Disturbances of visual discrimination and spatial perception are frequently observed consequences of brain disease, especially when there is damage to the right brain hemisphere (Benton & Tranel, 1993). A variety of tests have been developed to assess different aspects of visual discrimination. A number of these measures require subjects to match or discriminate unfamiliar faces (Tzavaras, Hecaen, & LeBras, 1970; Warrington & James, 1967). These tests were originally devised based on the assumption that they would assess some of the same mechanisms underlying prosopagnosia. Although this assumption has been proven unfounded, tests of this type nevertheless remain in common use. Studies using such measures in nonaphasic patients with unilateral brain disease have typically demonstrated poorer performance in patients with right-hemisphere lesions (Bentin & Gordon, 1979; DeRenzi & Spinnler, 1966; Benton & Van Allen, 1968). One of the most popular of the facial discrimination tasks has been the Facial Recognition Test (FRT) (Benton, Hamsher, Varney, & Spreen, 1983). This test consists of three parts: (1) matching of identical front-view
photographs, (2) matching of front-view with three-quarter view photographs, and (3) matching of front-view photographs under different lighting conditions.

Initial studies using the FRT provided a number of interesting findings. Hamsher, Levin, and Benton (1979) examined FRT performance in 145 right-handed patients with unilateral focal cerebral lesions. Among nonaphasic patients, only those with right-hemisphere disease showed a high number of defective performances. Among patients with right-hemisphere disease, those with posterior lesions showed a higher frequency of defective performance than those with anterior lesions. No significant relationship was found between the presence of visual field defects (VFD) and FRT performance in patients with either right or left brain lesions.

The latter finding seems particularly interesting in view of the commonly observed difficulty that patients suffering visual field defects may have on discrimination tasks that require visual search. The FRT does make some demand on visual search, since it requires subjects to sort through six pictures on a page to find ones that match the target item. One explanation may be that patients with simple VFD can learn to compensate for their field defects by turning their heads and searching methodically from one side to the other so that all items in front of them eventually come into view in the ipsilateral or “good visual field.” Clinical experience with VFD patients reveals that many can learn to perform complex visual search tasks, including reading, quite well. One of the problems encountered in clinical practice is that many patients, particularly those with posterior lesions, may exhibit some combination of visual field defect and neglect. For our purpose, neglect is defined as the failure to report, respond, or orient to meaningful stimuli presented to the side opposite a brain lesion, when this failure cannot be attributed exclusively to sensory or motor defects (Heilman, 1979). Many patients with severe neglect may present a much different picture than ones with only VFD. While patients with VFD may learn rather easily to scan, particularly with help from auditory and physical cues, those with substantial neglect may benefit to a minimal degree, if at all, from such cues. Patients with neglect may have a very difficult time orienting themselves in any manner to the affected side. The visual neglect may also be accompanied by some degree of sensory and motor impairment on the affected side. Commonly, such patients are unable to locate items placed just past midline on the affected side. Substantial effort may be required to help the patient search through the entire visual field even to see items that are there, much less examine them closely. Because of these compelling problems, patients with neglect should have a more difficult time performing the FRT. Although this point might seem self-evident to clinicians familiar with such patients, the issue has not been examined empirically. In fact, previous studies have not actually addressed the issue of neglect in relationship to FRT performance. This study was designed to examine the relationship between FRT performance and visual neglect in patients with unilateral vascular lesions. Our hypothesis was that visual neglect would interfere with visual search and discrimination and therefore have an adverse effect on FRT performance.

**METHOD**

**Subjects**

The subjects were 85 patients with right-hemisphere cerebrovascular lesions (RCVA) and 45 patients with left-hemisphere cerebrovascular lesions (LCVA). RCVA and LCVA patients all had documented histories of acute unilateral stroke. All were tested within six weeks of onset. Radiographic testing, including a CT scan at a minimum, ruled out the presence of other brain lesions. We excluded patients having known history of prior stroke, head trauma with loss of consciousness, seizures, tumors or infectious disease involving the brain, alcohol
abuse, drug abuse, psychosis, or major depression. Of the 85 RCVA patients, 33 (or 39%) exhibited evidence of left visual neglect. Of the 45 LCVA patients, only six (or 13%) showed evidence of right visual neglect. Demographic characteristics of the patient groups are presented in Table 1.

### Procedure

All subjects were evaluated using a comprehensive battery of neuropsychological tests, including, when appropriate, the Wechsler Adult Intelligence Scale-Revised, measures of expressive and receptive language functioning, tests of visual and verbal learning, measures of visual perception, tests of visual spatial ability, and measures of sensory and motor capability. As part of the evaluation, all subjects were administered the Short Form of the FRT (Levin et al., 1975). This test consists of the first 27 items from the longer 54-item version. Correlations between the two forms range from .88 to .94. Evidence of visual neglect was obtained from several sources, including clinical observation and formal testing. In cases of severe neglect, the presence of neglect was apparent from observation. Such patients had difficulty simply orienting to the affected side, many showing a particular gaze preference. Formal measures, included visual confrontation testing from the Halstead-Reitan Sensory Perceptual Examination, a constructional drawing battery, a task requiring patients to locate geometric figures on a page, and a task requiring patients to read a line of single digit numbers. On the visual confrontation testing task, patients were required to make four or more errors in one visual field before they were considered to have signs of possible neglect. On the drawing tasks, which included 10 simple designs, omission of one side of a design or consistent distortion of one side of the designs was considered a sign of neglect. On the symbol search task, inability to locate two or more forms on one side of midline was considered suggestive of neglect. On the number reading task, failure to observe two or more items on one side of midline was considered to be a sign of neglect. A fifth, but more subjective criteria, was substantial inability of the patient to benefit from auditory verbal and physical cues designed to encourage the individual to search the entire visual field. All patients were required to meet the fifth criterion, as well as two of the first four criteria in order to be designated as having neglect. The fifth criterion was considered essential because patients with simple VFD (i.e., hemianopsia) may exhibit some of the same errors as described in criteria 1–4. Requiring the fifth criterion was to help distinguish between patients with VFD who make errors due to problems with visual search versus those with true neglect, who have difficulty orienting to the affected side even when provided with auditory verbal and physical cues.
TABLE 2
Distribution of Corrected FRT Scores in Clinical Groups

<table>
<thead>
<tr>
<th>FRT Score</th>
<th>With Neglect</th>
<th>Without Neglect</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RCVA (n = 33)</td>
<td>LCVA (n = 6)</td>
</tr>
<tr>
<td>Normal (41 and up)</td>
<td>4/33 (12%)</td>
<td>3/6 (50%)</td>
</tr>
<tr>
<td>Borderline (39–40)</td>
<td>2/33 (6%)</td>
<td>2/6 (33%)</td>
</tr>
<tr>
<td>Mild-Moderate Impairment (37–38)</td>
<td>2/33 (6%)</td>
<td>0/6 (0%)</td>
</tr>
<tr>
<td>Severe Impairment (36 or less)</td>
<td>25/33 (74%)</td>
<td>1/6 (17%)</td>
</tr>
</tbody>
</table>

Although no systematic effort was made to exclude patients with aphasia, we did follow the general rule that in order to obtain valid scores from the tests, it was essential that patients be able to comprehend the nature of the task and to execute an appropriate response. Unfortunately, this is often not the case with patients suffering from severe receptive or global aphasia. While some would argue that from a methodological standpoint such subjects should be included in studies of this type, it makes little practical sense to include test results from subjects who clearly do not comprehend the task at hand and who may make little, if any, effort to respond appropriately. Consequently, there were a number of patients with severe receptive or global aphasia who were not included in the study.

RESULTS

FRT Short Form scores were converted to Long Form scores using the conversion tables provided by Benton et al. (1983). The latter scores were corrected for age and education. Patients' corrected raw scores were divided into four categories, using guidelines suggested in the test manual:

1. Normal: 40 and up,
2. Borderline Normal: 39–40,
3. Mild-Moderate Impairment: 37–38, and
4. Severe Impairment: 36 or less.

Patients were further subdivided into two groups, those with neglect and those without neglect. Results are presented in Table 2.

The incidence of impaired FRT performance (i.e., scores lower than 39) among RCVA patients (53%) was significantly higher than among LCVA patients (27%). RCVA patients also exhibited a significantly higher percentage of contralateral neglect (39%) than did LCVA patients (13%). For the RCVA group, the percentage of patients obtaining impaired FRT scores was significantly higher for those with neglect (82%) than those without (35%). However, for the LCVA group, the percentage of patients obtaining impaired FRT scores was about the same for those with and without neglect (17% vs. 28%). Mean FRT scores for RCVA patients with and without neglect were 32.97 and 40.27, respectively. Mean scores for
LCVA patients with and without neglect were 41.2 and 41.0, respectively. Analysis of variance revealed that RCVA patients with neglect scored significantly lower than the other three patient subgroups, $F(3,126) = 11.70, p < .001$. The remaining subgroups did not differ significantly from one another.

Pearson product-moment correlations between WAIS-R Verbal (V.I.Q.) and Performance (P.I.Q.) scores and FRT scores were calculated. Correlations between FRT and V.I.Q. were nonsignificant for all 4 subgroups. FRT and P.I.Q. correlations also were not significant in LCVA subgroups. However, the P.I.Q and FRT correlations were significant for both RCVA patients with neglect ($r = .60, p < .01$) and those without neglect ($r = .62, p < .01$).

**DISCUSSION**

Results from this study support the sensitivity of the FRT as a measure of visual discrimination in patients who have suffered unilateral stroke. RCVA patients exhibited a much higher incidence of impairment on the FRT than did LCVA patients. However, about one-fourth of LCVA patients did show some degree of impairment. Even so, LCVA patients with impaired FRT performance tended to score within the mild- moderate range, while almost 50% of RCVA patients obtained scores within the severely impaired range. These data generally confirm the previous finding of Hamsher et al. (1979). An additional contribution, however, was our analysis of the relationship between FRT performance and visual neglect. Among RCVA patients in our study, impaired FRT scores were observed much more frequently in patients with significant visual neglect. LCVA patients with or without neglect exhibited about the same rate of impairment. These results supported the experimental hypotheses and confirmed observations that neglect is a serious phenomenon affecting FRT performance. Correlations between FRT scores and the WAIS-R Performance I.Q. in RCVA patients suggest that facial discrimination may be related strongly to other perceptual functions mediated by the right hemisphere of the brain. However, the observation of severely impaired FRT performance in 10 LCVA patients would suggest that other mechanisms may be active as well. First of all, impaired visual search may be responsible for part of the deficit that CVA patients experience when confronted with a task such as the FRT. If this assumption is true, then poor FRT performance could be observed in either RCVA or LCVA patients who have visual search problems due to neglect. Additionally, problems may occur with simple VFD if patients have not learned to compensate sufficiently.

Another issue is that while studies have shown a left visual field superiority for accuracy and speed of identification of unfamiliar faces (Hannay & Rogers, 1979; St. John, 1981), it is possible that some patients may exhibit a right field superiority for such material (Benton & Tranel, 1993). In such patients, left-hemisphere lesions could understandably affect FRT performance. However, such patients would not necessarily be expected to perform poorly on all WAIS-R performance tasks, which tap into a wider range of perceptual, constructional, and spatial abilities. Hence, correlations between FRT and WAIS-R measures may not be significant.

One issue not addressed by this study was whether lesions were located anteriorly or posteriorly within the hemisphere. While some patients had lesions that could be thus classified, many had larger lesions involving the middle cerebral artery distributions and crossing over traditional boundaries between anterior and posterior aspects of the brain. A logical extension of this study would be to examine the relationship between FRT scores and neglect in patients with more localized lesions limited to either the anterior or posterior sections of the hemisphere. This would be helpful in determining further whether impaired FRT performance is a function of neglect per se, or whether it is related to other functions traditionally associated with posterior cerebral portions of the brain.
REFERENCES


