The patient who has sustained a severe head injury, causing diffuse damage, is likely to exhibit severe functional, cognitive, perceptual-motor, and physical impairments. One area of perceptual-motor impairment we commonly encounter is constructional apraxia. The observed prevalence of this impairment, often accompanied by severe functional limitations, points to the possibility of a relationship between constructional ability and level of function. The literature as it applies to 1. constructional apraxia exhibited in the patient with severe head trauma, and 2. the relationship of constructional apraxia to functional abilities in these patients, is limited. The following is an overview of the information available on these two subjects.

In 1934, Kleist originated the concept of constructional apraxia and defined it as “activities such as assembling, building and drawing, in which the spatial form of the product proves to be unsuccessful, without there being an apraxia of single movements.” (1, p 1) When Kleist first described the impairment, he stated the lesion was in the posterior parietal lobe of the left hemisphere. McDougall supported this belief when he stated, “Constructional apraxia is an important and commonly occurring event in cases of parietal disease.” (2, p 172) However, in the 1930s, it was further shown that patients with right hemisphere damage also exhibited the impairment (2). Constructional apraxia, therefore, could occur when either hemisphere has been damaged.

Although it has been established that constructional apraxia is present in patients with right or left hemispheric damage, one has to wonder whether the deficit differs.
constructional praxis into at least two different types and that each type be recognized separately in testing and in the analysis of results.

It is apparent from the studies just described that some type of constructional disability is often present in the stroke patient. How then does this impairment relate to function? Warrington, Merle and Kinsbourne (4) support these hemispheric differences. Their study shows that the types of errors in drawings made by patients with right hemisphere damage suggest a difficulty in incorporating spatial information into their drawing performance. Patients with left hemisphere damage seemed to experience difficulty in planning the drawing (4). In a study by Ben-Yishay et al., they observed that differential performance between right and left hemiplegic patients was also shown in a block design task with left hemiplegics demonstrating more constructional deviations (5).

Benton adds another dimension to the comparison of constructional apraxia and location of lesion by showing that the degree of association between the deficit of constructional apraxia and the location of the lesion depends in part on the tasks selected by the tester (1). In the study by Warrington et al. (4), no evidence for difference in severity of disability, depending on the hemisphere, was established. This study, however, used only a series of copying drawings for its test tasks.

Constructional apraxia may be tested in a number of different ways, and the literature includes studies using block arranging, block building, stick arranging, design copy, and free drawing (1-3, 6, 8). In research with 100 brain-damaged patients, Benton (1) established a difference in performance between three-dimensional and graphic tasks. He suggested dividing constructional praxis into at least two lesion site. Still other studies disagree on the occurrence of the impairment depending on the method of evaluation employed. Finally, although two studies identify a relationship between constructional apraxia and dressing for the stroke patient (localized lesions), similar studies on the head trauma patient with nonlocalized multiple lesions are unavailable. This scant information evidences two important needs for research and documentation. First, there is a need for a study of constructional praxis that will test and analyze all three areas (graphic, matchstick designs, and block designs). Second, there is a need for comparison of performance in constructional praxis and dressing in patients with nonlocalized lesions.

The purpose of this study was to determine whether any significant correlation exists between graphic, two-dimensional, and three-dimensional apraxia and difficulty in dressing in the patient who has sustained a severe head injury with nonlocalized, multiple lesions.

Methods

Subjects. This study involved 37 patients, 12 females and 25 males, admitted to the head injury rehabilitation service of Santa Clara Valley Medical Center. Each patient had sustained severe head injuries (at least 6 hours of coma) and was thought to have rehabilitation potential by the admitting physician. Their ages ranged from 16 to 51 years, with a mean age of 27 and a median age of 23. Their disability score on the Disability Rating Scale (9) at the time of occupational therapy evaluation ranged from 0 (normal) to 20 (extremely severe disability), with a mean score of 8.5 and a median score of 7 (moderately severe disability).

Disability Rating Scale. The scale...
includes the items of the Glasgow Coma Scale (eye opening response; best verbal response; best motor response) (10); level of functioning in terms of degree of dependence on others (11); cognitive awareness with respect to toileting, feeding, and grooming; and level of employability (9). The maximum score is 30 (death). Disability Rating Scale scores were included in this study to provide information on the range of disability in the population and the relationship between an overall level of functional disability and specific constructional praxis and dressing problems.

**Raters.** The evaluators consisted of eight occupational therapists. The same therapist rated the constructional praxis and dressing scores for each patient. The therapist rating any given patient on the constructional praxis and dressing skills tests (concurrently with several other types of evaluations) was not aware that a study of the relationship of these factors would be made. Disability ratings were made by nonoccupational therapy staff who were unaware of occupational therapy ratings.

To ensure the reliability of ratings, the evaluators were trained to administer, score, and interpret patient behavior in a standardized manner. Each therapist that rotated onto the head injury service was required to observe at least one complete patient evaluation, and to record what he or she thought was the appropriate rating. The results were compared with those of the supervisor and discussed between the supervisor and therapist. When independent ratings on the same patient were done after therapist training, all inter-rater reliabilities were significant at the .01 level of confidence.

**Constructional Praxis Measures.**
Figure 3
Rating Scale

0 No impairment
Requires no physical or verbal assistance; able to perform the task within a reasonable amount of time (i.e., 30 minutes for dressing and hygiene). Can use adaptive equipment, but is able to handle the equipment on their own.

1 Mild impairment
a. Unable to perform task within a reasonable amount of time (i.e., 30 minutes for dressing and hygiene).
b. Requires occasional verbal assistance
c. Requires setup of adaptive equipment
d. Any combination of a, b, and c.

2 Moderate impairment
a. Unable to perform within a reasonable amount of time (i.e., 30 minutes for dressing and hygiene).
b. Requires standby verbal assistance
c. Requires intermittent physical assistance with device or manual.
d. Any of the following combinations: a, b, and c; b and c; a and c; or b; or c is rated as moderate impairment.

3 Severe impairment
a. Unable to perform within a reasonable amount of time (i.e., 30 minutes for dressing and hygiene).
b. Requires consistent physical assistance with device and/or manual.
c. Requires consistent verbal assistance.
d. Any of the following combinations: a, b, and c; b and c; a and c; or b; or c is rated severe impairment.

4 Unable — Pt
Patient unable to perform tasks at all

N.T. — not tested
Patient was not given test due to, for example, no time, not an appropriate goal (i.e., kitchen skills for nursing home placement).

U.T. — unable to test
Patient unable to take test due to, for example, language barrier, medical and/or orthopedic complications, or any other complications unrelated to Head Injury.

The constructional praxis section of Hemiplegic Evaluation, developed at Massachusetts Rehabilitation Hospital, was used to assess graphic, two-dimensional, and three-dimensional motor planning skills (12). For each of the three areas of praxis tested, the patient was asked to copy the test designs. If problems were noted, the therapist performed the tasks and asked the patient to follow her example.

The graphic section involved the following sequence of designs, with maximum time to complete the task: 1. horizontal line (5 sec), 2. vertical line (5 sec), 3. cross (5 sec), 4. circle (5 sec), 5. square (10 sec), 6. triangle (10 sec), 7. diamond (10 sec), 8. cube (20 sec), 9. house (1 min), 10. clock (1 min). Clinical rating of the performance included the following: scrawlings, overscoring, fractionation, perseveration, spatial neglect, alterations in spatial relations, verticality, and poor planning. Performance was graded as intact: 0; impaired: 1; severely impaired: 2; or unable to perform: 3. These performance ratings were also used for two-dimensional and three-dimensional praxis tasks.

For two-dimensional praxis, the patient, after completing a practice design to ensure comprehension of the task instructions, was then asked to construct matchstick designs within 20 to 30 seconds (see Figure 1). Clinical ratings of abnormality included verticality, increased number of acute or right angles, wrong end of the matchstick used, and inaccurate number of sticks.

For three-dimensional praxis, the patient constructed block designs (see Figure 2). Clinical rating of abnormality included poor planning, verticality, alterations of spatial relations, misplaced plane, and inaccurate number of blocks.

Dressing Measures. Dressing, evaluated in the morning in the patient’s room, included: button-down garment on and off, slipover shirt on and off, slacks/underpants/skirt on and off, bra on and off, socks/stockings on and off, shoes on and off, fastenings—buttons/zippers/belt, and ability to get clothes from closet/drawer. The mean score of the eight dressing items was used. The patient’s performance was rated using a scale established for the study (see Figure 3).

Because of conflicting studies in the earlier literature on hemispheric differences, Computerized Axial Tomography (CAT) scan results were investigated in this study in an attempt to differentiate perfor-

Table 1
Correlations among Variables Collected on Patients With Severe Head Injuries

<table>
<thead>
<tr>
<th>N</th>
<th>Disability</th>
<th>Dressing</th>
<th>Graphic</th>
<th>2-dimens.</th>
<th>3-dimens.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Age</td>
<td>37</td>
<td>-0.092</td>
<td>-0.002</td>
<td>0.016</td>
<td>-0.016</td>
</tr>
<tr>
<td>2. Disability</td>
<td>37</td>
<td>-0.002</td>
<td>0.016</td>
<td>0.801*</td>
<td>0.812*</td>
</tr>
<tr>
<td>3. Dressing</td>
<td>37</td>
<td>-0.002</td>
<td>0.016</td>
<td>0.801*</td>
<td>0.812*</td>
</tr>
<tr>
<td>4. Graphic</td>
<td>37</td>
<td>-0.002</td>
<td>0.016</td>
<td>0.801*</td>
<td>0.812*</td>
</tr>
<tr>
<td>5. 2-Dimens.</td>
<td>26</td>
<td>-0.002</td>
<td>0.016</td>
<td>0.801*</td>
<td>0.812*</td>
</tr>
<tr>
<td>6. 3-Dimens.</td>
<td>23</td>
<td>-0.002</td>
<td>0.016</td>
<td>0.801*</td>
<td>0.812*</td>
</tr>
</tbody>
</table>

* p < .01

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performance by left or right hemisphere damage.

Results

From the eight items relating to dressing activities, a mean dressing score was obtained. Likewise, a constructional praxis mean score was obtained for each of the three types (graphic, two-dimensional, and three-dimensional). Pearson r correlations were computed among age, level of disability, mean dressing score, and the three mean constructional praxis scores (graphic, two-dimensional, and three-dimensional). The results are shown in Table 1.

The correlations among the three mean constructional praxis scores are highly significant. Age is not significantly related to any of the variables measured, even the level of disability. Mean dressing score is related to level of disability and all three constructional praxis scores at the .01 level of confidence. Level of disability is also significantly related to the three constructional praxis mean scores (p < .01).

CAT scan information was available on 28 of the 37 subjects; 10 had normal scans; 5 showed left hemisphere damage; 6 had right hemisphere damage; and 7, bilateral damage. Because of the small groups, those with left, right, and bilateral damage were grouped together and compared to those with normal scans on dressing and the three apraxia measures. Although those with normal scans consistently had lower mean disability scores than those with abnormal scans, no significant differences between groups were found on any of the four measures.

Discussion and Conclusions

Lorenze and Cancro established a correlation between impaired visual praxis with the stroke patient (6). Williams established a relationship between drawing and dressing abilities, also with the stroke patient (8). He expanded on previous documented findings by comparing constructional praxis and dressing abilities for the head-injured population. The significant correlation between dressing and constructional praxis, no longer limited to stroke patients, is present also in the patient with a severe head injury with nonlocalized lesions. It is therefore vital for the occupational therapist to include praxis in the disability evaluation. By doing so, the therapist can more accurately perceive possible reasons for dressing dysfunction. Constructional praxis is only one of many perceptual motor impairments affecting dressing ability that may appear as a result of severe head injury. It is hoped that additional research will find other impairments that also bear a correlation with dressing ability.

Unlike Benton (1), we found no significant difference in performance of graphic, two-dimensional, and three-dimensional praxis. Further studies should indicate whether it is necessary to test all three areas of praxis with this patient population. With this type of information, unnecessary and often time-consuming tests can be eliminated from the perceptual evaluation.

It would be of value to discover what impact training would have for dressing and constructional praxis skills. In addition, a recovery trend, or pattern of recovery, comparing dressing and praxis over time, would benefit clinicians. In the future, it is possible that clinicians could pinpoint the exact stage in the patient’s recovery where therapeutic intervention would have the most impact.

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