The relationship between constructional apraxia and body scheme disorders and failure of post-cerebral vascular accident (CVA) patients to achieve independence in upper extremity dressing was investigated in this study. One hundred and one subjects with right- and left-CVA were given tests that measured body scheme dysfunction and constructional apraxia on admission to an inpatient rehabilitation unit, and then rated on upper extremity dressing performance at discharge.

Scores on the apraxia and body scheme tests were statistically correlated with dressing performance. The results indicated that both constructional apraxia and body scheme dysfunction contribute to failure in achieving upper extremity dressing, but that body scheme performance is a better predictor of dressing ability. In addition, the presence of visual field deficits, medical complications, and aphasia were found to exert significant influence on subject performance.

One of the most frustrating problems encountered by therapists who work in stroke rehabilitation is the patient who is unable to achieve independence in basic dressing skills despite intensive training. These patients seem incapable of relearning the basic self-care skills they acquired in childhood. They often dress themselves no better at discharge than they did on admission, although

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they appear physically able and spend considerable time in self-care training.

Reports of such conditions have surfaced periodically in the literature on stroke since 1910 (1). In 1941, Brain (2) labeled the condition dressing apraxia and attributed it to an underlying visuospatial disorganization. According to Brain, such patients lose the ability to dress themselves because they no longer can visualize the spatial properties of clothing and match the correct garment opening to the correct body part. This inability is observed even though the patient displays adequate balance, strength, motivation, and cognition.

Research has suggested that a link exists between constructional and dressing apraxias (3-5). Constructional apraxia, as defined by Siev and Freishat, is "an impairment in producing designs in two or three dimensions by copying, drawing or constructing whether on command or spontaneously" (6, p 59). It is clinically tested by asking the patient to reproduce a series of simple drawings or models (7-10).

Lorenze and Cancro (11) investigated the relationship between constructional and dressing apraxias in hemiplegic subjects by correlating the presence of visuoconstructional deficits with failure to achieve independence in self-care tasks. They found that subjects who performed poorly on the constructional tests also failed on dressing tasks despite the intensive training. They concluded that a positive relationship exists between these two abilities and that performance on constructional tests can be used to predict success in self-care. Their research supported the conclusions of an earlier study by Williams (12) who used a similar research design to compare the ability of hemiplegic subjects to copy simple designs with their ability to perform upper extremity dressing.

Although disorders of body scheme are commonly acknowledged to contribute to difficulties in acquiring self-care skills, the nature of the relationship between these disorders and dressing apraxia has not been analyzed in the literature. This may be partly due to the controversy surrounding the definition of body scheme. Early researchers, notably Head and Holmes (13), defined body scheme as an internal model, developed and organized through multisensory experiences, which serves as the standard for all incoming sensory information. Subsequent researchers modified and expanded this basic concept, adding a diverse collection of characteristics including psychological phenomena. The end result, according to Poock and Orgass (14), in a comprehensive review of this subject, is a present-day concept of body scheme that is poorly defined and marked by discrepancies in theory, clinical symptomatology, and measurement. Despite the discrepancies in definition, researchers have attributed disorders in body scheme to the presence of dressing apraxia (2, 15-17).

Age, sex, and time elapsed since onset were not reported in the literature to be related to the incidence or severity of the three disorders. However, aphasia and visual field deficits (VFD) have been identified as influential factors.

Arena and Gainotti (8) reported aphasia to be significantly related to poor performance on constructional tasks, which supports earlier findings by Benton (18). Poock and Orgass (14, 19) found aphasia correlated significantly with impaired performance on body scheme tests, although Shontz (20) and Semmes and others (21) found no such correlation.

DeRenzi et al (9) reported visual field deficits to be significantly correlated with constructional apraxia with right hemisphere damage only. Other researchers found VFD more prevalent in right hemispheric lesions (3-5, 7, 22). We found no discussion of the relationship between VFD and body scheme disorders in the literature.

A desire to provide additional information on the relationship between constructional apraxia and body scheme disorders and failure to acquire independent dressing skills in post-CVA subjects led to this study. Specifically, the study sought to answer two questions: 1. Does a relationship exist between low scores on tests designed to measure constructional praxis and body scheme integration and failure to gain independence in upper extremity dressing at time of inpatient discharge? 2. Is one measure a better predictor of ultimate dressing performance than the other; that is, is constructional apraxia more highly correlated with dressing apraxia than body scheme dysfunction or vice versa? In addition, the parameters of age, sex, length of disability, presence of receptive and expressive aphasia, visual field deficits, and medical complications were analyzed to determine their influence on the subject’s performance.

Method

Subjects. The study sample consisted of 101 subjects: 55 males and 46 females. All subjects were inpatients at the Rehabilitation Institute of Kansas City, Missouri, between July 1978 and December 1979. Subject criteria for inclusion in the sample were: 1. A minimum age of 18 years; 2. Diagnosis of a CVA with evidence of a unilateral
lesion in either hemisphere; 3. To minimize the influence of extreme lethargy and confusion, a demonstrated ability to successfully participate in other evaluations (i.e., muscle test, etc.) prior to being tested; 4. To rule out other forms of apraxia or agraphia and severe receptive aphasia, a demonstrated ability to copy a vertical and horizontal line or write name on command, or both. Patients diagnosed as having either bilateral or diffuse undifferentiated brain lesions were excluded from the study. For the purpose of analysis, the subjects were divided into two groups; left (L) and right (R) CVA. The L-CVA group consisted of 32 males and 22 females (n = 54) ranging in age from 30 to 85 years with a mean age of 64.11 years. The R-CVA group consisted of 23 males and 24 females (n = 47) with an age range of 31 to 85 years and a mean age of 74.61 years. A t test of the mean age difference between the two groups failed to reach statistical significance (t (99) = .09, N.S.). Within the L-CVA group, 26 (55%) were diagnosed as having some degree of receptive or expressive aphasia, or both. Subjects in both groups displayed varying degrees of paralysis; however, paralysis was not considered an important parameter in this study.

Instruments. Three evaluations were used to assess each subject's performance in the areas of body scheme, constructional praxis, and dressing.

The Test of Body Scheme, developed by MacDonald (16), was used to evaluate the integration of body scheme in each subject. The test included seven subtests designed to evaluate two general areas of body scheme: 1. body identification, including finger identification, body parts, and right-left discrimination; and 2. body revitalization, including construction of a body puzzle and a draw-a-person test. The test was used exactly as presented by MacDonald with the addition of one point to the score on the draw-a-person test to account for an obvious deletion of a body part (i.e., draws one hand but not the other). A perfect score consisted of 43 points; according to MacDonald scores of 0 to 39 indicated a body scheme disorder.

To assess the presence of constructional apraxia, a series of four simple designs was selected on the basis of their use in other research (3, 10, 12). The designs consisted of a house, a clock, a flower, and a diamond. Each subject was requested to reproduce the designs on a separate sheet of paper as accurately as possible using the unaffected arm. The designs were presented on 10 x 20 cm (4 x 8-inch) cards, one at a time in the same sequence, and in the same position each time (centered at the subject's midline, 5.56 cm from the edge of the table). The subject was not allowed to move the design card but could rotate the paper. There was no time limit for completion of the drawings. Each drawing was scored on the basis of completeness, proportion, and recognizability with allowance made for use of the non-dominant extremity. Four points were possible on each drawing, a total of 16 points on the entire test. To reduce experimenter bias, the drawings were scored by a secretary knowledgeable in the scoring criteria, but not in the purpose of the test.

A 4-point scale was used to evaluate the subject's performance in dressing. The ability to put on a front opening or pullover shirt was the only performance criterion used. Lower extremity dressing was excluded because of the difficulty of separating the influence of balance and limited trunk range of motion (ROM) on the dressing performance. Allowance was made in the scoring criteria for the influence of obesity, pain, and limited ROM on performance.

Procedure. The evaluations were administered to all subjects. All 101 subjects were able to reliably complete the design copy test and the dressing evaluation. Only 85 subjects completed the body scheme test; 33 in the L-CVA group and 52 in the R-CVA group. Fourteen of the L-CVA group were unable to complete the test because of language problems; two in the R-CVA group refused to complete the test. All evaluations except dressing were administered in the occupational therapy department. Each subject was evaluated twice; within the first five days of admission, and just before discharge. The tests were administered by staff therapists and affiliate students trained in the evaluation procedures. Each subject received the same amount and type of dressing and perceptual training commonly provided, with the exception that a minimum of four, but not more than nine, self-care training sessions were provided each week.

Results

To investigate whether constructional apraxia and body scheme disorders contribute to failure to gain independence in upper extremity dressing, the initial scores on the body scheme and design copy tests were correlated with the final dressing scores using the Pearson Product Moment Correlation test. Correlation coefficients were calculated for the total sample and for the R- and L-CVA groups. Statistically significant correlations were found both between the design copy...
Table 1
Correlation between Initial Design Copy, Initial Body Scheme, and Final Dressing Scores

<table>
<thead>
<tr>
<th>Score Comparisons</th>
<th>L-CVA</th>
<th>R-CVA</th>
<th>Total Sample</th>
<th>p*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design copy &amp; dressing</td>
<td>.50</td>
<td>.38</td>
<td>.43</td>
<td>.01</td>
</tr>
<tr>
<td>Body scheme &amp; dressing</td>
<td>.44</td>
<td>.52</td>
<td>.67</td>
<td>.01</td>
</tr>
<tr>
<td>Body scheme &amp; design copy</td>
<td>.47</td>
<td>.57</td>
<td>.54</td>
<td>.01</td>
</tr>
</tbody>
</table>

*p was significant for all 3 groups

and dressing scores and the body scheme and dressing scores for the total sample and for the L- and R-CVA groups. These results are shown in Table 1.

To determine the correlation between the two tests, Pearson Product Moment Correlation coefficients were calculated on the body scheme and design copy scores for the total sample and for the R- and L-CVA subsamples. Those correlations (shown in Table 1) were statistically significant for all three groups.

To determine which test, body scheme or design copy, better predicted dressing performance, t tests of the difference in correlations for dependent groups were performed for the total sample and the R- and L-CVA groups. When the sample was divided into R- and L-CVA, however, no significant difference in the predictive ability of the two tests was shown for either group.

The percent of subjects failing to gain independence in upper extremity dressing at discharge was 32 percent for the total sample. (Note: A score of 3 or below on the dressing test was considered a failure.) When the L- and R-CVA groups were compared for dressing failures, 41 percent of the R-CVA group failed compared to 21 percent of the L-CVA group. A z-test of the difference in these two proportions was statistically significant (z (101) = 2.14, p < .05).

When the sample was divided into R- and L-CVA, however, no significant difference in the predictive ability of the two tests was shown for either group.

When the subjects who failed to achieve independence in dressing were considered separately, no significant correlations were found between their performances on the body scheme and design copy tests and the final dressing scores. However, a higher correlation was found between body scheme and dressing performance for this subsample than design copy. The small size of the subsample (n = 32) may have accounted for the failure of the data to achieve statistical significance.

Other factors possibly influencing the subjects' performance were investigated to determine their relationship to each of the variables under study. The six factors studied were: VFD, age, sex, time elapsed since onset (time frame), medical complications, and aphasia. Pearson Product Moment Correlation coefficients were calculated to determine the correlation between age and time frame and performance on the three tests; Point Biserial Correlation coefficients were calculated for the other factors.

Significant correlations between the presence of VFD and performance on the design copy and body scheme tests were found for the total sample and for the R-CVA subsample. Correlations in the L-CVA group failed to reach statistical significance. A significant correlation was also found between VFD and final dressing scores for the total sample but not for either subsample. These results are shown in Table 2. In addition, the R-CVA group displayed a significantly greater proportion of VFD than the L-CVA group (z (101) = 3.84 p < .01).

No significant correlation was found between the age of the subject and performance on the three tests, or between the sex of the subject and performance on the body scheme test. However, a significant correlation was found between sex and performance on the design copy test (see Table 2). The correlation reached statistical significance for the total sample and the R-CVA group, with females performing better than males. This finding, not
Table 2

<table>
<thead>
<tr>
<th>Score Comparisons</th>
<th>Correlation Coefficients</th>
<th>Total</th>
<th>Sample</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L-CVA</td>
<td>R-CVA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VFD &amp; Design Copy</td>
<td>.15</td>
<td>.52</td>
<td>.01</td>
<td>.39</td>
</tr>
<tr>
<td>VFD &amp; Body Scheme</td>
<td>.12</td>
<td>.41</td>
<td>.01</td>
<td>.35</td>
</tr>
<tr>
<td>VFD &amp; Dressing</td>
<td>.14</td>
<td>.27</td>
<td>NS</td>
<td>.23</td>
</tr>
<tr>
<td>Sex &amp; Design Copy</td>
<td>.01</td>
<td>.34</td>
<td>.05</td>
<td>.20</td>
</tr>
<tr>
<td>Sex &amp; Body Scheme</td>
<td>.05</td>
<td>.21</td>
<td>NS</td>
<td>.09</td>
</tr>
<tr>
<td>Time Frame &amp; Design Copy</td>
<td>Not Computed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time Frame &amp; Body Scheme</td>
<td>- .23</td>
<td>.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medical Complications &amp; Design Copy</td>
<td>Not Computed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medical Complications &amp; Body Scheme</td>
<td>Not Computed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aphasia &amp; Design Copy</td>
<td>.41</td>
<td>.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aphasia &amp; Body Scheme</td>
<td>.20</td>
<td>NS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aphasia &amp; Dressing</td>
<td>.21</td>
<td>NS</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NS: not significant

Significant negative correlations were found between time frame and the final design copy and dressing scores. A negative correlation was also found between final body scheme scores and time frame but it was not statistically significant. These results indicate that the greater the time elapsed since onset of the CVA, the poorer the performance in dressing and design copy. Initially, this appeared surprising, but after consideration it became apparent that, since the sample consisted entirely of inpatients, those subjects more severely debilitated by the stroke also required the longest period of rehabilitation. The correlation therefore suggests a relationship between severity of the disability and performance on these tests. These correlations are shown in Table 2.

The presence of medical complications during the hospitalization correlated significantly with the subject’s dressing performance at discharge (see Table 2), but not with performance on the final body scheme and design copy tests. Some of the medical complications observed were: severe pain, uncontrolled diabetes, pulmonary embolus, flu, transient ischemic attacks, and cardiac disorders.

In the L-CVA group, aphasia significantly correlated with performance on the design copy test only. Nonaphasics performed significantly higher on this test than aphasic subjects ($t(45) = 5.83, p < .01$). Nonaphasic subjects also performed better on the body scheme test and achieved a higher level of independence in dressing, although these results were not statistically significant. No significant correlation was found between performances on body scheme and dressing; however, 30 percent of the L-CVA subjects were unable to complete the body scheme test due to aphasia.

Discussion

The results of this study support the contention that disorders in body scheme and constructional apraxia are related to and contribute to dressing apraxia in post-CVA subjects. Dysfunction in both areas proved to correlate significantly with failure to gain independent dressing skills; however, the test of body scheme was a better predictor of dressing performance than the design copy test.

The significant correlation found between the body scheme and design copy tests suggests that the disorders of body scheme and constructional apraxia jointly contribute to the presence of dressing apraxia. This premise was tested on our data by singling out low design copy scores (12 points and below) associated with high body scheme scores (over
89 points) and comparing these scores with dressing performance. Within the total sample (n = 85), only 17 such scores were found. Of these, only three were associated with deficient dressing performance. When the same procedure was repeated isolating the low body scheme scores associated with high design copy scores, only nine scores were identified; of these, only one was associated with dressing failure. These results support the contention that both disorders are present in subjects displaying dressing apraxia.

However, a significant correlation between the body scheme and the design copy tests could also indicate that the two tests overlap each other on the functions they measure. Poeck and Orgass (14) maintained that, because the concept of body scheme is so poorly defined, tests used to measure it are frequently confounded by the presence of other neuropsychological dysfunction. The body scheme test includes an 11-point draw-a-person subtest that supports such a conclusion since the inability to freely draw designs accurately is an indication of constructional apraxia. A poor performance on this subtest could lower the subject's score on the entire test sufficiently to indicate a body scheme disorder when, in fact, none exists. To determine whether such a relationship was present within these data, subjects with deficient scores on the body scheme test (39 and below), and the design copy test (12 and below) were isolated from the data and analyzed. Thirty-one subjects met this criterion. Their scores on the draw-a-person subtest were rated as acceptable or deficient, using a score of 8 as the cutoff point. Twenty-one subjects, 65 percent of the subsample, had deficient scores on the subtest, suggesting a strong link between this subtest and the design copy test.

The finding that nearly twice as many subjects with R-CVA failed to achieve independence in upper extremity dressing supports conclusions drawn by other researchers (3, 4, 11, 23). McFie et al. (4) reported dressing apraxia to be approximately five times more prevalent with R-CVA, whereas Lorenze and Cancro (11) found it to be exclusively associated with damage to the R-hemisphere.

The predominance of VFD in the R-CVA sample also supported the literature. DeRenzi et al. (9) reported VFD to be more common with R-hemisphere damage and to be significantly correlated with constructional apraxia. Other research (4, 22) reported a greater incidence of VFD in subjects with R-hemispheric lesions.

The finding of a statistically significant correlation between VFD and deficient body scheme performance in the R-CVA group cannot be interpreted because of the lack of reported research in this area. However, any attempt to explain this result must be made with the knowledge that the design copy and body scheme tests were found to be significantly correlated within this group.

Aphasia appeared to have a significant influence on the performance of subjects in the L-CVA group. Nonaphasics consistently performed better on all three tests than their aphasic counterparts. While only the difference in design copy scores reached statistical significance, the fact that 30 percent of the sample was too aphasic to provide reliable results on the body scheme test suggests a greater influence of aphasia on this test than could be statistically indicated.

Arena and Gainotti (8) reported that 57 percent of their aphasic subjects demonstrated deficient scores on tests of constructional apraxia indicating a significant relationship between aphasia and visuo-constructive disturbances. The results of this study support their conclusion as does other research (13, 18). However, similar studies (24, 25) have failed to find any relationship between constructional apraxia and aphasia.

The finding that one-third of the subjects in the L-CVA group were unable to complete the body scheme test indicates that aphasia significantly interferes with the standard clinical techniques used to evaluate this syndrome. Poeck and Orgass (14) questioned the validity of using tests that require verbal responses to measure body scheme performance. They demonstrated that the commonly used methods to assess body scheme dysfunction correlate highly with the presence of aphasia. They concluded that it is impossible to reliably determine whether a poor performance on such tests is caused by a language deficit or a disturbance in body scheme. However, in a similar study, Semmes et al. (21) controlled for the presence of aphasia and found that its occurrence did not significantly alter the subject's performance.

The finding that the severity of the subject's illness following the CVA influenced ultimate achievement in dressing was not surprising. It is a common observation of therapists who work with stroke patients that those who suffer the greatest disability initially, and experience the most complications during recovery, often perform the poorest in self-care.

Summary and Conclusions

The results of this study support the existence of a relationship between

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constructional apraxia and body scheme disorders and the failure of hemiplegic subjects to acquire basic dressing skills. Both body scheme and design copy scores were significantly correlated with final dressing performance. Performance on the body scheme test proved to be a significantly better predictor of dressing performance than the design copy test. However, the significant correlation found between the two tests suggests that they overlap one another on the functions they evaluate. Therefore, it seems reasonable that both tests should be used to ensure an accurate assessment of the patient’s capabilities.

Differences in the representation of deficits in the two hemispheres became apparent when the performances of the R- and L-CVA subsamples were compared. The R-CVA group contained a significantly greater proportion of both dressing failures and visual field deficits than the L-CVA group. Aphasic subjects in this group appeared to play a significant role in the performance of subjects in the L-CVA group. Nonaphasic subjects in this group consistently performed better on the tasks of body scheme and design copy and achieved greater independence in self-care than their aphasic counterparts.

In general, the subject’s age and sex did not influence performance. However, the severity of the subject’s disability and the number of complications during recovery did significantly influence ultimate achievement in dressing.

Implications for Occupational Therapy. The significance for occupational therapy is that simple clinical tests may be used to predict the potential of a patient to benefit from dressing training. At a time when rising health-care costs have led to a greater scrutiny of health services, the need to identify those patients who will and will not benefit from occupational therapy services becomes very great. This study and others (11, 12) have laid a foundation for research in this area. It now becomes necessary to establish the validity of such tests and to standardize their use with the stroke population.

Acknowledgments
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