Correlation of Perceptual Performance and Activities of Daily Living in Stroke Patients

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Twenty-five male stroke patients were assessed with the use of a battery of perceptual tests (Gross Visual Skills [Baum, 1981], Adult Visual-Perceptual Assessment [Baylor University Medical Center, Occupational Therapy Department, 1980], Manikin and Feature Profile subtests of the Arthur Point Scale of Performance Tests [Arthur, 1943; Buros, 1974, 1978], Judgment of Line Orientation [Benton, Varney, & DeS. Hamsher, 1978], Bender Visual Motor Gestalt Test [Bender, 1946], Haptic Visual Discrimination Test [McCarron & Dial, 1976, 1979a, 1979b], Block Design and Object Assembly subtests of the Wechsler Adult Intelligence Scale–Revised [Wechsler, 1981], and Test of Three-Dimensional Constructional Praxis [Benton, 1973a; Benton & Fogel, 1962]). Also administered was the Klein–Bell ADL Scale (Klein & Bell, 1982) to measure performance of activities of daily living. The research questions were as follows: (a) To what extent did this sample of stroke patients differ from the normative samples on perceptual performance? (b) To what extent did any tests of perceptual performance correlate with performance of activities of daily living? and (c) What, if any, instruments were more useful in discriminating the perceptual performance of stroke patients from that of normative samples? The results indicated that stroke patients showed significant deficits in perceptual performance, some of which correlated with activities of daily living performance. Patients with right hemispheric lesions performed similarly to those with left hemispheric lesions except on the Haptic Visual Discrimination Test.

The incidence of cerebrovascular accident in the United States has declined since the late 1960s (Dombovy, Sandok, & Basford, 1986; Hertanu, Demopoulos, Yang, Calhoun, & Fenigstein, 1984). Dombovy et al., however, reported that survival after stroke and the population of elderly people susceptible to stroke are both increasing.

Occupational therapy has been one of the key disciplines used for the assessment and treatment of patients who must learn to live with the residual disability produced by cerebrovascular accident (Ayres, 1962; Ostrow, Lieberman, Merrill, Kaplan, & Joe, 1985; Taylor, 1968; Trombly, 1983). Independence in activities of daily living (i.e., dressing, hygiene and grooming, eating, and other self-care activities) is basic to the achievement of self-sufficiency and self-directedness. To accomplish these treatment goals, therapists evaluate and treat capabilities and dysfunction in the motor, sensory, and perceptual systems.

Perceptual performance is defined as the ability to organize, process, and interpret incoming visual information, tactile-kinesthetic information, or both, and to act appropriately on the basis of the information received (Abreu, 1981; Bernspång, 1987; Bernspång, Asplund, 1987).
Although perceptual performance has been observed clinically to influence the accomplishment of rehabilitation objectives, a lack of consistency has been evident in the definition and management of perception and its components. Consequently, the relationship between perceptual abilities and desired functional goals needs clarification.

Studies of patients with cerebrovascular accident have involved many different assessments of perceptual performance with variable standards of measurement (Boys, Fisher, Holzberg, & Reid, 1988; Gersten, Jung, & Brooks, 1972; Halperin & Cohen, 1971; Jimenez, Keltz, Stein, & White, 1976; Jones, 1977; Jongbloed, 1986; Ottenbacher, 1980; Rout, 1978). These studies have been employed to serve as baseline evaluations of function, to identify deficit areas for treatment, and to predict rehabilitation potential. Perceptual tests have also been used as diagnostic tools or as descriptors of cerebral hemispheric functions (Arena & Gainotti, 1978; Benton, 1975b; Black & Strub, 1976; Colombo, De Renzi, & Faglioni, 1976; Dee, 1970; Hécaen & Assai, 1970; McFie, Piercy, & Zangwill, 1950; McFie & Zangwill, 1960; Piercy, Hécaen, & De Ajuriaguerra, 1960; Warrington, James, & Kinsbourne, 1966).

**The Problem**

Stroke affects not only patients’ motor function but also their perceptual abilities (Trombly, 1983). Occupational therapists, however, need to know more about their patients’ specific perceptual deficits and how these might correlate with performance of activities of daily living. Such information might enable occupational therapists to intervene more effectively either by improving perceptual performance in order to improve activities of daily living performance or by teaching patients to compensate for deficits.

The relationship between lesions’ loci and perceptual performance is unclear. Stroke patients with right hemispheric lesions often do less well in achieving levels of self-care independence than do those with left hemispheric lesions (McCullough & Sarmiento, 1970; Rout, 1978; Taylor, 1968). Perceptual dysfunction might be one of the factors responsible for these patients’ reduced skill reacquisition of activities of daily living (Halperin & Cohen, 1971; Kaplan & Hier, 1982; Taylor, 1968).

Occupational therapists also treat patients with left hemispheric lesions (i.e., those who have right hemiparesis). We need to ask the following question: To what extent are perceptual performance deficits to be expected in this group and, if present, are they also correlated with performance of activities of daily living?

Measurement is part of the problem. In previous studies reporting a correlation between standardized perceptual tests and activities of daily living performance, a single perceptual test has usually been correlated with a single parameter of activities of daily living skills (e.g., dressing) (Baum & Hall, 1981; Bradley, 1982; Mitcham, 1982; Warren, 1981; Williams, 1967). Few studies have addressed associations between activities of daily living and perceptual performance from a multidimensional perspective. Because perceptual performance can be assessed in different ways emphasizing different sensory modalities or performance requirements, it appears important to employ a wide range of assessments in order to evaluate perceptual performance comprehensively. Ideally, the instruments used to measure perceptual performance would be standardized, reliable, valid, and practical for use by occupational therapists in a clinical setting and would require minimal to no verbalization by the stroke patient.

The instruments that occupational therapists employ to measure performance of activities of daily living vary widely. Self-care items and methods of grading differ among scales. The relative importance of activities of daily living items and categories, indicated by weighted scores, produce different performance assessment scores. Most activities of daily living scales have been designed for clinical rather than research use, thus, standardized testing procedures and data to support reliability and validity are lacking. Comparisons of stroke patients’ performance on such a wide range of assessments administered under differing conditions, therefore, are difficult.

Occupational therapists may work in settings in which they wish to test patients’ perceptual performance. Faced with a bewildering array of available tests, however, it is difficult to decide which instruments might be the most useful.

To what extent do stroke patients display perceptual deficits that are perceived to affect occupational therapy programs? To what degree might any such deficits be related to the performance of daily living skills or to patients’ specific demographic characteristics? Such information could improve the formulation of occupational therapy goals, treatment procedures, and predictability of rehabilitation (i.e., activities of daily living) potential for stroke patients.

**Purpose**

The purposes of this study were (a) to determine to what extent a sample of 25 stroke patients would differ from normative samples on perceptual abilities, (b) to explore relationships between particular perceptual tests and performance of daily living tasks with the use of a comprehensive battery of standardized tests available to occupational therapists, and (c) to evaluate and compare the effectiveness of these assessments in identifying the deficits and abilities of this sample.
Method

Subjects

All patients with conditions diagnosed as cerebrovascular accident on the rehabilitation unit of the Audie L. Murphy Memorial Veterans' Hospital from July 1983 to June 1988 were evaluated by physicians for possible inclusion in this study. The patients included in the sample met the following criteria: (a) had a complete stroke (i.e., no further progressive neurological symptomatology); (b) had had no previous strokes; (c) had a single, unilateral cortical lesion, as confirmed by a computed tomography scan, within 6 months after onset of the stroke; (d) had a stable neurological examination; (e) showed medical stability; (f) had the ability to follow simple commands; and (g) had consented to participate in the study. Twenty-five patients met the criteria.

The subjects were all male and ranged in age from 34 to 78 years ($M = 59.2$ years of age). Sixteen of the subjects had a high school or some college education. Twelve subjects were Hispanic, 11 were Caucasian, and 2 were Black. At the time of testing, the subjects were a mean of 65.5 days after the onset of their strokes. Fifteen subjects had right hemispheric lesions (10 due to infarct; 5, hemorrhagic) and 10 had left hemispheric lesions (6 due to infarct; 3, hemorrhagic; 1, unspecified). With the exception of one left-handed subject (with a left hemispheric lesion), all subjects were right-handed.

In motor function, only 5 subjects—3 with right hemispheric lesions and 2 with left hemispheric lesions—had voluntary, controlled movement of the involved upper extremity. Of the 5 subjects with active upper extremity motion, 3 had intact sensation for pain, vibration, and position sense; 1 had mild to moderate impairment in all three sensory modalities; and 1 had mild to moderate impairment of position sense with pain and vibration intact.

Ten subjects exhibited upper extremity flaccidity, 7 subjects had spasticity with and without synergy, and 3 subjects did not have the motor status of the extremity recorded. These 20 subjects varied from intact to severe impairment in the areas of pain, vibration, and position sense.

Five subjects with aphasia were administered the Porch Index of Communicative Ability (Porch, 1967) by hospital speech pathologists to rule out those who had receptive aphasia, which would prevent them from following test instructions. The speech pathologists established that Subtests 6, Gestural (which involves pointing to an object in response to a question of function) and 10, Gestural (which involves pointing to an object when named) were appropriate for the establishment of adequate language comprehension receptivity. The language severity criterion for participation in this study was the 10th to the 80th percentile. All 5 subjects with aphasia scored within this range.

Instrumentation

A number of potential variables to include in perceptual assessments of stroke patients have been described (Baum, 1981; Boys et al., 1988; Farver & Farver, 1982; Feigenson, McDowell, Meese, McCarthy, & Greenberg, 1977; Gersten et al., 1972; Siev & Freishtat, 1976; Spencer, 1988). From these descriptions, the first author derived broad categories of perceptual dysfunction (Baum, 1981; Boys et al., 1988; Gersten et al., 1972; Siev & Freishtat, 1976; Spencer, 1988; Taylor, 1968), as follows: (a) gross visual skills, (b) visual-perceptual skills, (c) body scheme/body parts, (d) visuospatial orientation, (e) visualmotor skills, (f) agnosia, and (g) apraxia. Tests that could be used to assess these seven broad categories of perceptual dysfunction, found in Buros (1974, 1978) and Siev and Freishtat, are described below. They were selected because of their comprehensiveness, standardized administration procedures, availability for use by occupational therapists, lack of verbalization required by stroke patients, and ease of administration in a clinical setting. All instruments either had established reliability and validity or were assessed for these as part of our research.

Gross visual skills. The test used to assess these skills was Gross Visual Skills (Baum, 1981), which has five subtests. Visual Attention measures the ability to visually attend to a stationary object for a specified period of time. Ocular Pursuits measures the ability to visually track an object in a number of directions. Field Cut Testing (with and without a patch) indicates visual field deficits. Alternating Simultaneous Stimuli and Line Bisection measure visual neglect (Baum, 1981; Siev, Freishtat & Zoltan, 1986). The Alternating Simultaneous Stimuli subtest involves the therapist's wiggling of one or two fingers in front of the patient's face. The Line Bisection subtest requires the subject to intersect randomly placed lines with a pencil on a sheet of paper that extends to the right and left of midline.

The interrater reliability of the overall Gross Visual Skills assessment was reported to be .83 (Baum, 1981). Because visual skills can compromise performance on other perceptual tests, Baum's recommendation that this area be assessed first was followed. All subjects had to demonstrate gross visual skills in order to participate in the study. All subjects scored between 84% and 100% on this test, an adequate range for continued participation in the study. Because the subjects demonstrated insufficient variance in the visual skills scores, no further analyses were done on these data.

Visual-perceptual skills. The Adult Visual-Perceptual Assessment (Baylor University Medical Center, Occupational Therapy Department, 1980) was used to assess these skills. This test comprises six subtests: Figure-Ground, Form Constancy, Position in Space, Depth Perception, Visual Body Scheme, and Spatial Relations.

Figure-Ground requires the subject to identify three
items on a picture plate of imbedded objects and to point to three of six items that correspond to the plate. Form Constancy has two parts: (a) to identify a square and then point to designs that contain a square and (b) to identify a circle and then point to designs that contain a circle. Position in Space requires the subject to point to one of four designs that correspond to a displayed design. Depth Perception involves pointing to a block or blocks on a displayed picture plate in response to a verbal query, such as, “Which block is closest to you?” Visual Body Scheme requires the subject to make an X with a pencil on an outline of a figure when different body parts are shown on picture plates (e.g., nose, eyes). Spatial Relations requires the subject to duplicate with pencil and paper the displayed designs on a separate page. Because the authors of these tests did not report their respective tests’ reliability, we assessed test–retest reliability in the present study.

Body scheme/body parts. We selected two standardized tests suggested by Buros (1974, 1978) — the Manikin and Feature Profile subtests of the Arthur Point Scale of Performance Tests (Arthur, 1943) — to assess body scheme/body parts. Each of these tests produces two scores (construction and time) (Arthur, 1943), and the therapist administers them by presenting puzzle parts in a specific arrangement and asking the subject to assemble the parts. Test–retest reliability was assessed in the present study.

Visuospatial orientation. We used Form H of Judgment of Line Orientation (Benton, Varney, & Hamsher, 1978) to assess this category. This test assesses the capacity to judge the spatial orientation of lines in relation to a set of standard references. The subject is shown a series of designs of two lines of varying lengths and is required to point to two numbers on a corresponding design plate that match the position of the displayed lines. Internal consistency reliability is reported at .94 (Benton et al., 1978).

Visuomotor skills. We tested this category using the Bender Visual Motor Gestalt Test (Bender, 1946). In this test, a series of designs is shown to the subject, one at a time, and the subject reproduces the designs with paper and pencil. According to McCarron and Dial (1976), “the individual’s reproductions of the . . . designs are assumed to be determined by the integration of perceptual and motor processes” (p. 16). Test–retest reliability is reported at .89. Because scoring is based on errors in copying the designs (Koppitz, 1975), a higher score reflects a poorer performance.

Agnosia. For this category we used the Haptic Visual Discrimination Test (McCarron & Dial, 1976, 1979a, 1979b), which is “a standardized and quantitative method of assessing cutaneo-kinesthetic sensory processes” (McCarron & Dial, 1979b, p. 13). Four subtests, Shape, Size, Texture, and Configuration, involve the subject’s use of each hand to manipulate objects while his or her vision is occluded. Five pictures are displayed, and the subject must point to the one that corresponds to the manipulated objects. Overall test–retest reliability is .93. No reliability estimates were available on the subtests.

Apraxia. Apraxia, specifically, three-dimensional praxis, was measured by three tests, two of which were the Block Design and Object Assembly subtests of the Wechsler Adult Intelligence Scale—Revised (Wechsler, 1981). These were selected because of their frequent use even though they require supervision by a psychologist when employed by an occupational therapist. The Block Design subtest involves the reproduction of displayed designs with blocks. The Object Assembly subtest requires the completion of four puzzles. The administration manual reports internal consistency reliability as .87 and .68 for the Block Design and Object Assembly subtests, respectively.

The Test of Three-Dimensional Constructional Praxis (3rd ed.) (Benton, 1973a; Benton & Fogel, 1962) was also used in this category. This test requires the subject to assemble, join, or articulate parts to form a unitary structure according to a three-dimensional model (Benton & Fogel, 1962). Test–retest reliability was assessed in the present study.

In addition to testing these seven categories of perceptual performance, we tested activities of daily living functions, which we expect would be compromised by perceptual dysfunction. The Klein–Bell ADL Scale (Klein & Bell, 1982), a standardized, quantitative measure of activities of daily living performance, was selected because it assesses a wide range of activities of daily living functions. This scale contains weighted components requiring the direct observation of the patient’s performance. The components of the scale most frequently assessed by occupational therapists were used in this study: dressing, upper extremity hygiene, eating, and communication. The sections not included were elimination, mobility, and bathing. Interrater reliability and predictive validity were reported as follows: 92% agreement between independent raters and r = .86 between the Klein–Bell ADL Scale score and the amount of assistance required in daily living skills after discharge from rehabilitation. Scores from each of the four components and the total score were correlated with scores on the measures of perceptual performance.

Data Collection

Data were collected by two registered occupational therapists (the first and fourth authors) between July 1983 and June 1988. A private room was used to test the subjects on the perceptual tests and the on the communication component of the Klein–Bell ADL Scale. Testing did not exceed 2 hr at any time. All eating, dressing, and upper extremity hygiene tasks (except shaving) were assessed.
in the patients’ rooms. Shaving was performed in the occupational therapy physical disabilities clinic.

Test-retest reliability was determined for the Adult Visual-Perceptual Assessment, the Manikin and Feature Profile subtests, and the Test of Three-Dimensional Constructional Praxis, all of which had been lacking reliability data. These tests were repeated with a mean interval of 12.1 days on 23 subjects. (The range of 3 to 25 days due to the clinical priorities of the hospital environment should be considered in the interpretation of the reliability coefficients.)

Results

Data Analysis

All correlational analyses, including calculations of test-retest reliability, were performed with Spearman rank order correlations. For dichotomous variables, reliabilities were calculated with a Kappa statistic for interrater agreement (Fleiss, 1981).

Test– Retest Reliability

The Adult Visual-Perceptual Assessment showed test-retest reliabilities as follows for each subtest: Figure-Ground, .72; Position in Space, .17; Form Constancy, .77; Depth Perception, .52; and Spatial Relations, .52. (test-retest reliability for Visual Body Scheme could not be computed due to lack of variation on the second test).

The Manikin and Feature Profile subtests each required two test-retest reliability estimates—one for construction and a second for time. These estimates were as follows: Feature Profile (construction), .59; Feature Profile (time), .61; Manikin (construction), +.10; and Manikin (time), .53.

Test– retest reliability for the Test of Three-Dimensional Constructional Praxis was .82.

Research Question 1: To what extent did this sample of stroke patients differ from the normative samples on perceptual performance? We compared the data from our 25 subjects with the normative data provided by the authors of the standardized assessments. Comparisons were made to selected samples according to age- and sex-appropriate normative data.

Because normative data were not available for the Manikin and Feature Profile subtests, no comparisons were made. Table 1 displays sample means and their translation into standard deviation units below the normative means, ordered from greatest to smallest deficit. (Because standard deviations were not reported for these normative comparison samples, t tests of significant differences could not be computed.) These data are reported so that other researchers might compare their samples with ours.

Table 2 compares our sample means to those normative means with reported standard deviations on the Test of Three-Dimensional Constructional Praxis and on the Adult Visual-Perceptual Assessment. We used t tests for independent samples to compare the mean performance of the sample with the appropriate normative sample. When variances were significantly different between the two groups, Welch’s t test (Zar, 1984) for nonhomogeneous samples was used. Our sample scored significantly lower than the normative samples on the Test of Three-Dimensional Constructional Praxis and on the Adult Visual-Perceptual Assessment subtests of Figure-Ground, Form Constancy, Position in Space, Depth Perception, and Spatial Relations (p < .001).

Because our sample consisted of 15 subjects with right hemispheric lesions and 10 with left hemispheric lesions, we tested for differences between these groups on all perceptual tests using nonparametric Wilcoxon

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**Table 1**

<table>
<thead>
<tr>
<th>Test</th>
<th>Sample M (N=25)</th>
<th>SD</th>
<th>Normative M</th>
<th>SD</th>
<th>N (Normative Sample)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bender Visual Motor Gestalt Test</td>
<td>16.28</td>
<td></td>
<td>-4.0</td>
<td></td>
<td>na</td>
</tr>
<tr>
<td>Haptic Visual Discrimination Test</td>
<td>15.92</td>
<td></td>
<td>-4.0</td>
<td></td>
<td>2,000</td>
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<td>Haptic Visual Discrimination Test</td>
<td>20.76</td>
<td></td>
<td>-3.0</td>
<td></td>
<td>2,000</td>
</tr>
<tr>
<td>Wechsler Adult Intelligence Scale—Revised, Block Design</td>
<td>6.84</td>
<td></td>
<td>-1.0</td>
<td></td>
<td>1,280</td>
</tr>
<tr>
<td>Wechsler Adult Intelligence Scale—Revised, Object Assembly</td>
<td>7.12</td>
<td></td>
<td>-1.0</td>
<td></td>
<td>1,280</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test</th>
<th>Sample M (N=25)</th>
<th>SD</th>
<th>Normative M</th>
<th>SD</th>
<th>N (Normative Sample)</th>
</tr>
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<tbody>
<tr>
<td>Test of Three-Dimensional Constructional Praxis</td>
<td>23.16*</td>
<td>7.60</td>
<td>28.83</td>
<td>0.60</td>
<td>120</td>
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<tr>
<td>Adult Visual Perceptual Assessment</td>
<td>13.36*</td>
<td>1.41</td>
<td>14.48</td>
<td>0.71</td>
<td>81</td>
</tr>
<tr>
<td>Figure-Ground</td>
<td>8.24*</td>
<td>1.86</td>
<td>9.55</td>
<td>0.73</td>
<td>81</td>
</tr>
<tr>
<td>Form Constancy</td>
<td>4.60*</td>
<td>0.76</td>
<td>4.81</td>
<td>0.54</td>
<td>81</td>
</tr>
<tr>
<td>Position in Space</td>
<td>5.72*</td>
<td>1.57</td>
<td>4.78</td>
<td>0.59</td>
<td>81</td>
</tr>
<tr>
<td>Depth Perception</td>
<td>25.60*</td>
<td>1.53</td>
<td>26.69</td>
<td>1.01</td>
<td>81</td>
</tr>
<tr>
<td>Spatial Relations</td>
<td>4.96</td>
<td>0.20</td>
<td>4.62</td>
<td>0.89</td>
<td>81</td>
</tr>
</tbody>
</table>

* (Benton, 1979a; Benton & Fogel, 1962). ** (Baylor University Medical Center, Occupational Therapy Department, 1980).  
*significant differences at p < .001.

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signed rank tests. The only statistically significant differences were found in the Haptic Visual Discrimination Test. The subjects with right hemispheric lesions performed significantly lower on the total score for the left hand ($p < .0001$) and on the subtests of Shape ($p < .0006$), Size ($p < .0001$), and Configuration ($p < .0001$) with the left hand. The subjects with left hemispheric lesions performed statistically lower on Shape ($p < .0006$) and Configuration ($p < .0015$) with the right hand.

To summarize, we found perceptual deficits in an array of categories. These deficits appeared in subjects with both left and right hemispheric lesions. The subjects with left hemispheric lesions performed better on the left-handed Haptic Visual Discrimination Test subtests, and those with right hemispheric lesions performed better on the right-handed Haptic Visual Discrimination Test subtests. Otherwise, there were no statistically significant differences between the subjects with right or left lesions. 

Research Question 2: To what extent did categories of perceptual performance correlate with performance of activities of daily living? Spearman rank order correlations were computed to estimate the degree of association between the score of each of the perceptual tests with overall activities of daily living performance scores as well as each subcategory score (i.e., dressing, upper extremity hygiene, eating, and communication). A correlation of $r = .39$ reached the .05 level of significance for this sample size of 25 subjects.

For dressing, the only statistically significant correlation was with the Shape subtest of the Haptic Visual Discrimination Test with the use of the left hand ($r = .47, p = .02$).

Seven statistically significant correlations were found with performance of upper extremity hygiene. The Block Design subtest of the Wechsler Adult Intelligence Scale–Revised had the strongest relationship ($r = .55, p = .004$), followed by the Shape and Texture subtests of the Haptic Visual Discrimination Test with the left hand ($r = .47, p = .020; r = .46, p = .020$, respectively), the Spatial Relations subtest of the Haptic Visual Discrimination Test ($r = .43, p = .030$), the total score of the Haptic Visual Discrimination Test for the left hand ($r = .42, p = .040$), the Judgment of Line Orientation ($r = .41, p = .040$), and the Manikin subtest (time) ($r = -.39, p = .050$).

Spearman rank order correlations between eating and perceptual performance were found to be statistically significant. The highest correlation was with the Figure–Ground subtest of the Adult Visual-Perceptual Assessment ($r = .57, p = .003$), followed by the Feature Profile subtest (construction) ($r = .55, p = .005$), the Judgment of Line Orientation ($r = .53, p = .010$), the Block Design subtest of the Wechsler Adult Intelligence Scale–Revised ($r = .49, p = .010$), the Manikin subtest (time) ($r = -.46, p = .020$), the Test of Three-Dimensional Constructional Praxis ($r = .44, p = .030$), and the Spatial Relations subtest of the Adult Visual-Perceptual Assessment ($r = .41, p = .040$). For communication, the only statistically significant correlation was with the Depth Perception subtest of the Adult Visual-Perceptual Assessment ($r = .50, p = .01$).

Spearman rank order correlations were also calculated for total activities of daily living performance (i.e., combined scores for dressing, eating, upper extremity hygiene, and communication). The strongest relationship was with the Shape subtest of the Haptic Visual Discrimination Test with the left hand ($r = .51, p = .01$), followed by the Texture subtest of the Haptic Visual Discrimination Test with the left hand ($r = .45, p = .02$) and the Block Design subtest of the Wechsler Adult Intelligence Scale–Revised ($r = .41, p = .04$).

Research Question 3: Which, if any, tests were more useful in discriminating the perceptual performance of stroke patients from that of normative samples? Using the criterion of statistical significance (see Table 2), we found that the Test of Three-Dimensional Constructional Praxis and the Figure–Ground, Form Constancy, Position in Space, Depth Perception, and Spatial Relations subtests of the Adult Visual-Perceptual Assessment were the most discriminating. Other instruments did not differentiae the sample from normative comparison groups or could not be tested statistically. The Bender Visual Motor Gestalt Test, which requires the copying of designs, and the Haptic Visual Discrimination Test total scores of both the right and left hands, which requires identification of objects manipulated by the hand, were three to four standard deviations below the normative mean scores.

A multiple-regression analysis was used to assess to what degree age, days after onset of stroke, side of lesion, or any combination of these variables could be used to predict perceptual abilities and performance of activities of daily living. Because so many comparisons were made, a Bonferroni adjustment was used to set each alpha level at .002, a very conservative level.

The only clinical variable that we could use to predict perceptual ability was the side of the lesion, which could be used to predict performance on one assessment only—the Haptic Visual Discrimination Test. We could predict that subjects with left hemispheric lesions would perform less well than subjects with right hemispheric lesions on the total test for the right hand ($t(21) = -3.56, p < .002$) and would perform significantly better than subjects with right hemispheric lesions on the subtests of Size for the left hand ($t(21) = 4.08, p < .001$) and Configuration for the left hand ($t(21) = 4.79, p < .001$).

Discussion

Perceptual performance dysfunction was present in this sample of 25 stroke patients, who performed significantly lower than the normative samples on several assessments. Deficits were found in subjects with right and left hemispheric lesions. A clinical implication is that all
stroke patients, regardless of the side of lesion, should be assessed for perceptual abilities. The Adult Visual-Perceptual Assessment, the Bender Visual Motor Gestalt Test, the Judgment of Line Orientation, the Test of Three-Dimensional Constructional Praxis, and the Haptic Visual Discrimination Test were the most discriminating in differentiating this sample of stroke patients from normative samples on perceptual performance.

For the purpose of measuring perceptual deficits accurately and consistently, we found these instruments to demonstrate major advantages. They were standardized so that researchers and clinicians could be confident of the reliability and validity of scores obtained. Several exceptions should be noted, however. First, very low test–retest reliability coefficients were found in this study for the Position in Space subtest of the Adult Visual-Perceptual Assessment (.17) and for the Manikin subtest (construction) (−.10); therefore, these tests should not be used to assess change. Possibly, these coefficients reflected neurological changes in the subjects between tests, deficits in test procedures, or a learning effect due to repeated testing.

Second, the tests used in this study did not require verbalization and thus were appropriate for patients with expressive aphasia. Third, all assessments except for the Block Design and Object Assembly subtests of the Wechsler Adult Intelligence Scale–Revised may be employed independently by occupational therapists.

With the exceptions noted above, occupational therapists might use these perceptual assessments to establish a baseline before initiating treatment and to monitor progress at intervals. To preserve the efficacy of the tests, therapists should keep testing separate from treatment. Treatment approaches used to modify perceptual abilities should use materials that are not found on standardized tests.

Correlations were found between some perceptual test scores and the dressing, hygiene, eating, communication, and total scores for the activities of daily living test. Thus it appears that in our sample, perceptual abilities were related to daily living skills. As Benton (1973a) asserted, however, performance of some of these tests is complex, demanding “sustained attention and capacity for planned activity” (p. 36). These tests might therefore measure other abilities in addition to perception.

Dressing was primarily related to the Shape and Texture subtests of the Haptic Visual Discrimination Test for the left hand. Because 15 of 25 patients had right hemispheric lesions with left hemiparesis, this correlation might be attributed to sensory and motor deficits in the left hand that interfered with both discrimination by touch and aspects of dressing requiring such discrimination. Because dressing requires positioning clothing in space, it was somewhat surprising that stronger correlations were not found with constructional praxis, spatial relations, or body scheme. Perhaps dressing requires a higher component of motor skill, as suggested by Bernspang et al. (1987), or perhaps the dressing tasks assessed by the Klein–Bell ADL Scale emphasized the capacity to position the entire body in space more than perceptual performance per se.

Hygiene correlated with a wide array of perceptual tests, some of which measured perceptual-motor, constructive skills while others were primarily concerned with visual or haptic perception. Discrimination of shape and texture with the left hand correlated with hygiene as they did with dressing, possibly reflecting sensory or motor deficits in the left hand for 15 out of 25 subjects with right hemispheric lesions. Perhaps both dressing and hygiene require more reliance on use of the left hand than do other activities of daily living.

Eating also correlated with many of the perceptual tests, but it related to different perceptual skills than did those found for dressing and hygiene. Several tests required construction, whereas others emphasized visuospatial relations. Haptic discrimination did not seem to relate to eating as strongly as to dressing and hygiene, perhaps because eating requires more of a unilateral skill.

Depth perception was the only perceptual test that correlated with communication, perhaps because this test requires the subject to bring a telephone receiver to the ear and dial a number.

The total score of these activities of daily living correlated with the Haptic Visual Discrimination Test for shape and texture with the left hand as well as the Block Design subtest of the Wechsler Adult Intelligence Scale–Revised. The total score for dressing, hygiene, eating, and communication thus may reflect both the ability to discriminate with the left hand and the three-dimensional praxis required for the manipulation of objects in space.

None of the visual-perceptual tests related significantly to total activities of daily living performance. Studies by Berntson et al. (1987) showed that perceptual-motor abilities (i.e., those abilities that require both organization and action) were significant predictors of self-care and activities of daily living in stroke patients, whereas visual perception alone (i.e., those abilities not requiring motor performance) was not. Thus, our findings seem to corroborate those of Bernspang et al.

The perceptual tests showing the most consistent correlation with activities of daily living were the Haptic Visual Discrimination Test, the Block Design subtest of the Wechsler Adult Intelligence Scale–Revised, the Test of Three-Dimensional Constructional Praxis, and the subtests of the Adult Visual-Perceptual Assessment. Occupational therapists might consider using these tests as both clinical and research tools in order to identify perceptual performance deficits that might affect activities of daily living performance. Excluding the Position in Space subtest of the Adult Visual-Perceptual Assessment, these tests appear to have adequate reliability and validity, standardized administration procedures, appropriateness for use...
with the population of stroke patients, and accessibility to occupational therapists to support their use.

The Klein-Bell ADL Scale had previous research support for its reliability and validity (Klein & Bell, 1982). In the present study, it was easily administered to stroke patients and comprehensive in its assessment of these daily living skills.

The present study demonstrated the complexity of perceptual performance. In this sample, it was not possible to predict such performance solely on the basis of age, days after onset of stroke, or side of lesion (except for with use of the Haptic Visual Discrimination Test). Many factors other than any single variable probably contribute to both perceptual skills and performance of activities of daily living in stroke patients.

We reached several conclusions regarding the assessment methods employed in this study. Because of limitations in the endurance and attention span of stroke patients, we recommend the limiting of assessment time and frequent rest periods. This will ensure that the data generated accurately represent the patients' actual abilities.

Because of its correlation with some activities of daily living functions and its strong test–retest reliability, the Test of Three-Dimensional Constructional Praxis might be explored by occupational therapists for use in research and clinical assessment of apraxia. For realistic testing, the block models should be used rather than the requirement that subjects reproduce models from photographs (Benton & Fogel, 1962; Bradley, 1982). Similarly, therapists instructing rehabilitation patients should use demonstrations rather than photographs or drawings alone.

One should consider the limitations of this study when interpreting the results. The small sample size of 25 subjects limited the power of the statistical tools. The subjects were selected from one hospital only and had a mean age that might have been younger than the typical stroke population. The subjects had a documented first lesion: Results would likely differ with subjects with multiple lesions. The similarity between the correlations found in our study and in the literature, however, increases confidence in the validity of these findings.

The length of time between the first and second tests for the establishment of test–retest reliability varied. This could have affected the coefficients obtained for the three assessments for which reliability was established in this research.

Conclusion

The sample of 25 stroke patients used in this study demonstrated a wide range of perceptual deficits. These deficits, most notably in constructional praxis and haptic visual discrimination, were related to the performance of activities of daily living. The Judgment of Line Orientation, the Bender Visual Motor Gestalt Test, the Haptic Visual Discrimination Test, the Test of Three-Dimensional Constructional Praxis, the Block Design and Object Assembly subtests of the Wechsler Adult Intelligence Scale–Revised, and four of the Adult Visual-Perceptual Assessment subtests were the most useful indicators of perceptual performance.

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