Visual Perception and Praxis in Adults After Stroke

Christine Draves York, Sharon A. Cermak

Key Words: apraxia • assessment process, occupational therapy • cerebrovascular disorders • perceptual training • rehabilitation

Objectives. The purpose of this study was to examine the performance of persons with right cerebrovascular accident (RCVA) and persons with left cerebrovascular accident (LCVA) on a variety of measures of praxis and visual perception in order to examine the relative contributions of the left and right cerebral hemispheres to praxis and perception.

Methods. Forty-five subjects, 15 with RCVA, 15 with LCVA, and 15 without CVA (control subjects), were tested on three tests of praxis—praxic production, gesture comprehension, and gesture discrimination—and selected tests of visual perception, including the Judgment of Line Orientation Test, the Motor Free Visual Perception Test, the Hooper Visual Organization Test, and the Line Bisection Test.

Results. Subjects in both groups with CVA performed more poorly on all of the tests than did control subjects. The group with LCVA performed most poorly on tests of gesture comprehension and praxis production, whereas the group with RCVA performed most poorly on tests of gesture discrimination and visual perception.

Conclusion. These findings suggest that both the right and left cerebral hemispheres contribute to different aspects of praxis. Elements of visual perception may be related to gesture comprehension, gesture discrimination, and praxis production in adults who have had stroke. These findings have clinical implications regarding instructional style and perceptual and praxic training.

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Subjects who had apraxia and aphasia had more difficulty in the discrimination and comprehension of gestures than did subjects who had aphasia but did not have apraxia (Heilman et al., 1982; Rothi et al., 1985). Subjects with right hemisphere brain damage were not included in these studies.

The contribution of the right cerebral hemisphere to praxis has been studied less often than that of the left cerebral hemisphere, even though its possible involvement has long been noted. In 1900, Leipmann wrote, “We will note once and for all that the right hemisphere, too, is involved in praxis, especially for the left half of the body” (cited in Rapcask, Ochipa, Beeson, & Rubens, 1993, p. 182). Other studies (Barbieri & DeReni, 1988; DeReni et al., 1980) found that 20% to 34% of persons with right hemisphere brain damage did make gestural errors to command and imitation, a finding suggesting a role of the right hemisphere in some praxic functions. Leipmann wrote, “We will note once and for all that the right hemisphere, too, is involved in praxis, especially for the left half of the body.”

The role of the left cerebral hemisphere in gesture recognition, discrimination, and production is well defined, but further exploration is required to determine the role of the right cerebral hemisphere in these functions. Lesions in the right hemisphere result in various forms of visual perception deficits (Heilman & Valenstein, 1993; Okkema, 1993; Siev et al., 1986). Therefore, it is possible that impairments of visual perception may influence the analysis of gestures for comprehension, discrimination and, possibly, production – especially in the praxic understanding of the motor program within a precise sequence of movements.

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Method

Subjects

The sample included 45 subjects, 15 subjects in each of three groups: subjects with LCVA, subjects with RCVA, and subjects without CVA (control subjects). Patients who met the criteria for participation and who consented to participate in the study were selected consecutively through admission to two rehabilitation hospitals in Portland, Maine over a 1½-year period. Study criteria for CVA subjects were that the subjects (a) displayed evidence of a unilateral RCVA or LCVA as determined by a computed tomography scan, magnetic resonance imaging, or neurologic evaluation and had no previous neurologic history, (b) were right-handed, (c) were 45 years to 75 years of age, (d) had a stroke at least 2 weeks but no more than 6 months before the study, (e) were oriented and cooperative, and (f) had at least an eighth-grade education.

Control subjects were selected from the orthopedic floor of one of the rehabilitation hospitals and met the same criteria as the subjects with CVA for age, handedness and education. These subjects had no known neurologic deficits. Data for all subjects are reported in Table 1.

Instrumentation

The measures used in the study were the auditory subtest from the Western Aphasia Battery (Kertesz, 1979), a series of visual-perceptual tests, and three praxis tests. The auditory comprehension subtest of the Western Aphasia Battery (Kertesz, 1979) was administered to the subjects to ensure adequate comprehension in order to complete testing. If the subject failed to meet the scoring criterion on this test, his or her participation in the study would be terminated. To calculate the scores, the number of correct responses from each subject was divided by 20 and then scaled to obtain an aphasia quotient. The maximum score that could be obtained was 10. Scoring of this subtest is based on locus of lesion. For left hemisphere–anterior brain lesions, a score of 4.0 or more is required. For left hemisphere–posterior lesions, a score of 7.0 or
Three tests were administered: a test of gesture production, a test of gesture comprehension, and a test of gesture discrimination. The gesture production test that was used was the Florida Apraxia Screening Test (FAST) (Rothi & Heilman, 1985). The FAST consists of 15 representational gestures that the subject performs in response to verbal command (e.g., “Show me how you would use a hammer”). The subject is then asked to perform the tasks by imitating the examiner. Scoring is based on the number of correct responses. A score of 9 or fewer indicates apraxia, and a score from 10 to 15 indicates no apraxia.

The videotaped gesture comprehension test described by Lennox et al. (1988) (based on the work of Rothi & Heilman, 1985) was reconstructed for the present study because of the poor quality of the original tape. The manner in which the gestures were performed was retained. However, because of investigator biases, one item that portrayed a person smoking was replaced by an alternate item. The videotape depicts a person pretending to use different objects. While viewing the videotape, the subject points to the correct response in a book depicting four drawings positioned in a vertical format. This test includes 24 items, with two levels of 12 items each. In Level I, the correct response is the object in the pantomimed act, (e.g., if the pantomimed act is of someone hammering, the correct response is a hammer). In Level II, the correct response is the functional associate of the object in the pantomimed act (e.g., if the pantomimed act is of someone hammering, the functional associate and correct response is a nail). The four types of response choices include the correct response, semantic foil, motoric foil, and neutral foil. The semantic foil is a drawing of an object that could be associated with the correct object but requires a different action to pantomime its use. The motoric foil represents an object with similar motor components but is executed in a different plane. The neutral foil is an unrelated object. Responses are timed, and subjects are given a maximum of 15 sec per item. Scoring consists of the number of correct responses, with a maximum score of 24.

A videotaped test of gesture discrimination developed by Heilman et al. (1982) was reconstructed for the study to reduce the number of test items and to improve the quality of the tape. The videotape portrays well-performed and poorly performed pantomimed acts of persons using objects. The test includes four teaching trial items followed by 24 test items containing six separate pantomimed acts performed in four different manners: a movement performed correctly, a movement performed with a spatial rotation, a movement performed with body part as object, and a movement unrelated to the object. While viewing the videotape of a person performing an action, the subject is shown a drawing of an object and asked to indicate if the action on the videotape is accurate or inaccurate for this object. Each item is timed, and subjects are given a maximum of 15 sec. Scoring consists of the number of correct responses, and the maximum score is 24.

To examine the validity of this measure, 77 occupational therapy personnel were asked to view each item.

Table 1
Descriptive Subject Data

| Subject Variables | Group | | | | |
|-------------------|-------|---|---|---|
|                   | RCVA  | LCVA | Control |
| Age (years)       | M     | SD  | M    | SD  | M  |
|                   | (n = 15) | (n = 15) | (n = 15) |
|                   | 61.07 | 6.35 | 61.89 | 4.28 | 8.67 |
| Education (years) | M     | SD  | M    | SD  | M  |
|                   | 12.67 | 5.46 | 12.00 | 5.23 | 15.07 |
| Gender (number of subjects) | Men | Women | Men | Women | |
|                   | 9     | 8    | 6    | 7    | 9   |
| Time after onset of stroke (days) | M | SD | M | SD | N/A |
|                   | 41.67 | 37.66 | 50.00 | 36.42 | N/A |
| Lesion location (number of subjects) | Anterior | Posterior | Anterior | Posterior | |
|                   | 3     | 12   | 5    | 10    | N/A |
| Hemiparesis (number of subjects) | 15 | 7 | 15 | 4 | N/A |
| Visual deficits (number of subjects) | 1267 | 6107 | 6635 | 28 | 867 |
| Auditory comprehension (raw score) | M | SD | M | SD | N/A |
|                   | 9.95  | 0.17 | 9.17 | 1.02 | 10.00 |
|                   | N/A   | N/A  | N/A  | N/A  | N/A  |

Note: RCVA = right cerebrovascular accident, LCVA = left cerebrovascular accident, N/A = not applicable.
and respond as to whether the action was performed correctly or incorrectly. Overall accuracy across items was 94.3%, with a range from 79% to 100%.

Procedure

Once subjects passed the auditory comprehension subtest of the Western Aphasia Battery (Kertesz, 1979), the other tests were presented in a semicounterbalanced order, with each subject randomly assigned to a set of ordered test presentations. The order of testing was as follows: The FAST (Rothi & Heilman, 1985) always preceded the videotaped presentation. Videotaped test stimuli (gesture comprehension and gesture discrimination tests) were administered in separate sessions in a counterbalanced order. Tests of similar content including the Line Bisection Test (Schenkenberg, Bradford, & Ajax, 1980), the Judgment of Line Orientation Test (Benton, Hamsher, Varney, & Spreen, 1983), the MVPT (Bouska & Kwaty, 1980), and the VOT (Hooper, 1983) were administered in separate sessions in a counterbalanced order. Separation of similar test materials (e.g., line orientation tests, videotaped test stimuli, visual-perceptual testing) aided in reducing redundancy of test stimuli, avoiding the practice effect, and alleviating boredom associated with multiple and similar test presentations. Testing was conducted in two or three 30-min sessions and was completed within 1 week of the initial contact with the subject. All tests were administered and scored on the basis of recommended test procedures as described in the test manuals.

Data Analysis

To examine our hypotheses, contrast analyses were conducted on a one-way analysis of variance, one for each measure of visual perception and praxis with the procedures reported in Rosenthal and Rosnow (1991). Contrast analysis provides an empirical statement that tests the statistical significance that accounts for the variance in the means in the direction or trend of the hypothesis. Contrast analysis was used because there is an increase in statistical power that derives from employing a focused rather than an omnibus test of significance (Rosnow & Rosenthal, 1988).

In this study, the contrasts (Fx), composed of three subject groups, were set up in such a way that the results obtained from the several groups were compared (or contrasted) with the predictions on the basis of theory and previous empirical findings. A contrast weight (x) was assigned to the ordered levels of each independent variable (i.e., group membership) to define a linear trend in level of performance. The linear trend x's represent a numerical statement of a predicted change in the level of performance as group membership changed.

Effect sizes were calculated to measure the degree of difference as predicted between the mean scores of each of the three groups. Between-group t tests were performed to examine more fully which group types contributed to the differences. Because t tests increase the risk of Type 1 errors occurring, effect sizes were emphasized.

Results

Perceptual Tests

To examine the hypothesis that persons with RCVA would perform more poorly than would persons with LCVA and persons without CVA on tests of visual perception (Visual Organization Test [Hooper, 1983], Motor Free Visual Perception Test [Bouska & Kwaty, 1980], Judgment of Line Orientation Test [Benton et al., 1983]), contrast weights that reflected the hypothesis were assigned for each group as follows: RCVA group (-1), LCVA group (0), and control group (+1). For the line bisection test, the contrast weights were as follows: RCVA group (+1), control group (0) and LCVA group (-1). These weights suggest that the RCVA group would have the greatest left inattention, the control group would show little or no inattention, and the LCVA group would show minimal right bias. The contrast analyses demonstrated that the trend in the direction of the hypothesis was significant, thus supporting the hypothesis (see Table 2 for means and standard deviations and contrast Fx). The effect sizes were in the moderate (r = 0.46) to large range (r = 0.61).

In addition, between-group t tests for perceptual measures were computed, and effect sizes were calculated (see Table 3). With the exception of the line bisection test, the effect sizes across all the remaining perceptual tests showed the largest differences between the RCVA and control group, followed by the LCVA and control group. The smallest differences, although still of moderate magnitude, were found between RCVA and LCVA groups. For the line bisection test, the greatest difference was found between the RCVA and LCVA groups, followed by the RCVA and control groups and the LCVA and control groups.

Gesture Comprehension and Praxic Production Tests

To examine the hypothesis that persons with LCVA would perform more poorly than would persons with RCVA on tests of gesture comprehension and praxic production (FAST) (Rothi & Heilman, 1985) and that both groups would perform more poorly than would control subjects, contrast weights were assigned as follows: LCVA group (-1), RCVA group (0), and control group (+1). The group means, standard deviations, and contrast analyses are reported in Table 4. The contrast analyses were significant for both the FAST (command and imitation) and gesture comprehension test. Effect sizes for the gesture comprehension test and the FAST were moderate (r =
poorly (see Table 5). The effect size was largest between the RCVA and control groups (\( r = 0.62 \)). Smaller differences, although still of a moderate magnitude, were found between the LCVA and control groups (\( r = 0.38 \)) and between the RCVA and LCVA groups (\( r = 0.30 \)). Means and standard deviations for each group are reported in Table 4.

Discussion

Perception and Praxis

Traditionally, praxic deficits have been considered specific to left cerebral hemisphere damage (Geschwind, 1975) and visual-perceptual deficits have been considered primarily an indication of right cerebral hemisphere damage (Okkema, 1993; Siev et al., 1986). This study demonstrates that on tests of visual perception and praxic abilities, both persons with RCVA and persons with LCVA perform poorly when compared to persons without CVA and, on some aspects of praxis (specifically gesture discrimination), persons with RCVA perform more poorly than do persons with LCVA.

**Table 2**

Means, Standard Deviations, and Contrast Analyses for Perceptual Measures

<table>
<thead>
<tr>
<th>Group</th>
<th>RCVA</th>
<th>LCVA</th>
<th>Control</th>
<th>Contrast</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Visual Organization Test</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>( M )</td>
<td>18.80</td>
<td>21.70</td>
<td>24.43</td>
<td></td>
</tr>
<tr>
<td>( SD )</td>
<td>5.89</td>
<td>3.45</td>
<td>3.09</td>
<td>0.33</td>
</tr>
<tr>
<td>Effect size (( r ))</td>
<td>0.60</td>
<td>0.60</td>
<td>0.60</td>
<td>0.60</td>
</tr>
</tbody>
</table>

**Motor Free Visual Perceptual Test**

| \( M \)         | 24.13| 28.93| 33.33   |          |
| \( SD \)        | 7.07 | 6.23 | 2.53    | 0.49     |
| Effect size (\( r \)) | 0.60 | 0.60 | 0.60    | 0.60     |

**Line Bisection**

| \( M \)         | 16.86| 20.12| 24.74   | 0.75     |
| \( SD \)        | 5.45 | 5.64 | 5.86    | 0.62     |
| Effect size (\( r \)) | 0.60 | 0.60 | 0.60    | 0.60     |

**Line Orientation**

| \( M \)         | 16.86| 20.12| 24.74   |          |
| \( SD \)        | 5.45 | 5.64 | 5.86    | 0.62     |
| Effect size (\( r \)) | 0.60 | 0.60 | 0.60    | 0.60     |

Note: RCVA = right cerebrovascular accident, LCVA = left cerebrovascular accident.

Between-group \( t \) tests were performed and indicated significant differences between LCVA and control groups on the gesture comprehension and praxic production tests: The LCVA group performed significantly more poorly (see Table 5). The effect size was largest between the LCVA and control groups, followed by the RCVA and control groups, and the right and LCVA groups. For praxis measures, the effect sizes for the FAST (Rothi & Heilman, 1985) were of a larger magnitude (\( r = 0.25 \) to \( r = 0.70 \)) than for the gesture comprehension test (\( r = 0.15 \) to \( r = 0.43 \)) (see Table 4).

Gestural Discrimination Test

To examine the hypothesis that persons with RCVA would perform significantly more poorly than would persons with LCVA and that both groups would perform more poorly than persons without CVA on a gestural discrimination test, a contrast analysis was performed on a one-way analysis of variance with weights assigned as follows: RCVA group (\(-1\)), LCVA group (0), and control group (\(+1\)). The results supported the hypothesis (see Table 4). The effect size was of a large magnitude (\( r = 0.66 \)). Between-group \( t \) tests are reported in Table 5. The largest difference was between the RCVA and control groups (\( r = 0.62 \)). Smaller differences, although still of a moderate magnitude, were found between the LCVA and control groups (\( r = 0.38 \)) and between the RCVA and LCVA groups (\( r = 0.30 \)). Means and standard deviations for each group are reported in Table 4.

**Table 3**

Between-Group \( t \) tests and Effect Sizes for Perceptual Measures

<table>
<thead>
<tr>
<th>Group</th>
<th>RCVA and LCVA</th>
<th>RCVA and Control</th>
<th>LCVA and Control</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Visual Organization Test</strong></td>
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<td></td>
<td></td>
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<tr>
<td>( t ) test</td>
<td>3.65</td>
<td>4.43</td>
<td>3.90</td>
</tr>
<tr>
<td>Effect size</td>
<td>0.60</td>
<td>0.60</td>
<td>0.60</td>
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**Motor Free Perceptual Test**

| \( t \) test    | -2.15 | -4.15 | 3.24 |
| Effect size    | 0.38 | 0.67 | 0.54 |

**Line Orientation**

| \( t \) test    | -1.40 | -4.52 | 1.94 |
| Effect size    | 0.25 | 0.03 | 0.14 |

**Line Bisection**

| \( t \) test    | -2.74 | -2.85 | 1.78 |
| Effect size    | 0.46 | 0.41 | 0.30 |

Note: RCVA = right cerebrovascular accident, LCVA = left cerebrovascular accident.

\( * p < 0.05 \) \( ** p < 0.01 \) \( *** p < 0.001 \)
psychological studies in apraxia and related disorders

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study include analysis of the perceptual demands required for the comprehension and discrimination of gestures. In a test situation, the demands may not be as exacting as those required in real life. Test situations differ greatly from daily routine where multiple choices and various situations require interactive analysis, responses, and modifications of behaviors to achieve the most efficient motor response to a given situation.

There are several limitations to this study. Considerations include the small sample size (which influences the ability to generalize these results), the order of the tests, and the length of testing sessions. Other considerations include the subjects' attention span and level of concentration in response to multiple tests and lengthy test sessions.

Clinical Application

Occupational therapists need to be alert to the possibility of perceptual and praxic problems in patients with stroke, regardless of the side of their lesion. This study has suggested that persons with lesions in either cerebral hemisphere may have visual perceptual or praxic difficulties of varied degree. The assumption that performance traditionally considered to be mediated by the contralateral hemisphere is adequate may not be justified. Indeed, deficits may be present but displayed in different forms.

It has been suggested in the literature that the method of instructional style can influence the outcome of treatment and the level of patient participation (Tickle-Degnen & Rosenthal, 1986). A patient's response to situations and testing after a stroke cannot be explained solely by knowing the locus of lesion. Responses are influenced by perceptual, cognitive, language, and motor deficits, as well as by previous learning style. For example, it has been suggested that the best method of teaching a person with a left cerebral hemisphere lesion and aphasia may be through visual, nonverbal means, whereas the best method of teaching a person with a right cerebral hemisphere lesion may be through verbal instruction (Fordyce & Jones, 1966; Trombly, 1989). As found in this study, visual perceptual and praxic difficulties may result from lesions in either cerebral hemisphere; therefore, it is an oversimplification to dichotomize side of hemispheric lesion and treatment strategy.

Both praxic retraining (Borod, Fitzpatrick, Helm-Estabrooks, & Goodglass, 1989; Miller, 1986) and perceptual retraining (Neistadt, 1988; Okkema, 1993; Siev et al., 1986) may be beneficial for the patient who has difficulty comprehending or discriminating gestures used by the therapist or who has difficulty producing gestures to communicate. Several interventions of praxic and perceptual retraining are available to the clinician and have been described in the literature (Aflorter, 1987; Bonfils, 1994; Helm-Estabrooks, Fitzpatrick, & Barresi, 1982; Miller, 1986; Neistadt, 1988; Okkema, 1993; Siev et al., 1986; Toglia, 1991). Considerations that may facilitate patient performance include examination of the sensorimotor and perceptual–conceptual components of the task and evaluation of the task in relation to the patient's learning style and interests (Goodgold-Edwards & Cermak, 1990).

Adapting the environment and task and varying the type of cueing and the practice demands and conditions in which the task is performed are strategies for promoting successful patient performance (Goodgold-Edwards & Cermak, 1990; Neistadt, 1988; Toglia, 1991).

The efficacy of the praxic and perceptual retraining methods suggested above needs further investigation. An in-depth analysis of visual perceptual skills required for praxis would assist in clarifying the role and function of the right cerebral hemisphere in the motor planning process. Similarly, further analysis and documentation of the error types produced by persons with RCVA and persons with LCVA would provide valuable information toward a better understanding of praxis.

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References


