Evaluating the Visual-Perceptual Skills of Children With Cerebral Palsy

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The Test of Visual-Perceptual Skills (TVPS) was used to determine if children with cerebral palsy demonstrated problems in visual perception on a motor-free visual perception test. Twenty-four children with cerebral palsy and 24 normal children, all of normal intelligence, were given the TVPS. Results showed that children with cerebral palsy attained significantly lower mean perceptual quotients than did the normal children. The TVPS appears to be a useful tool for the occupational therapist in evaluating visual perception in children with cerebral palsy.

Gibson (1969) defines visual perception as the process by which we obtain firsthand information about the world around us. Perceptual learning is an increase in the ability to extract information from the environment. This increase comes with experience and practice and through stimulation from the environment. The development of visual perception begins at birth with the reception of visual stimuli, followed by orientation of the head and eyes and the identification and integration of dominant visual cues (Chalfant & Scheffelin, 1969). The infant learns to attend to relevant aspects of visual stimuli, to make discriminations, and to interpret available cues in specific experience-related ways (Williams, 1983). Abercrombie (1964) states that “the more accurately a child can direct his eyes to a target, and the longer he can maintain fixation when required, the less will be the proportion of time that irrelevant images occupy the retina and fovea, the quicker he will learn to perceive” (p. 25).

In the developing child, there is a systematic increase in the ability to perceptually analyze and discriminate objects. For children between 5 and 11 years of age, a response to a whole figure rather than the details of a figure is the most immediate form of a perceptual response. The ability to perceive fragments of objects is difficult for young children and improves with maturity (Birch & Lefford, 1967). Figure-ground perception improves from 3 to 5 years with stabilized growth at 6 to 7 years. Form constancy development shows dramatic improvement from ages 6 to 7 years, with development leveling off at 8 to 9 years. Position in space development is complete at 7 to 9 years, and spatial relationships improve through approximately 10 years of age (Williams, 1983). If visual-perceptual development is identified by age levels, then the maturation of specific visual-perceptual skills appears to be well developed by 9 years of age.

People with cerebral palsy (CP) have frequently been identified as a group with visual perceptual deficits (Abercrombie, 1963; Black, 1982; Breakey, Wilson, & Wilson, 1974; Cruickshank, 1976; Hardy, 1983; Marks, 1974).

Early research indicated that the degree of perceptual impairment in persons with CP was related to the type of CP and the severity of the motor impairment (Abercrombie, 1964; Birch, 1964; Skatvedt, 1960; Wedell, 1960; Wood, 1955). Athetoid children have been found to have fewer visual-perceptual disorders than spastic children (Abercrombie, 1964). Wedell administered perceptual tests to the following groups of children aged 6 to 10 years: athetoid, bilateral spastic, right hemiplegic, and left hemiplegic. Perceptual impairment was found to be associated with spasticity. Bilateral and left-hemiplegic children
scored significantly lower than the athetoid or right-hemiplegic groups. Skatvedt (1960) found that children with bilateral spasticity presented the highest incidence of visual-perceptual deficits, followed by left-hemiplegic, and then right-hemiplegic children. However, Wood (1955) found no significant differences between right- and left-hemiplegic children on visual-perceptual tests of figure-ground perception and visual closure. Abercrombie (1964) stated that in spite of the various findings in studying hemiplegic groups, both right- and left-hemiplegic children have visual-perceptual problems.

Although it is logical to think that the various motor disorders found in the subtypes of CP are caused by different brain lesions, with both the size and location of the lesion influencing performance, studies with CP children have not examined the relationship of specific locus of cortical lesion, other than right/left hemisphere, to perceptual or perceptual-motor functions (Hardy, 1983; Menkes, 1980; O’Reilly & Walentynowicz, 1981; Rose, 1979).

The majority of available studies evaluating visual-perceptual skills in the child with CP were conducted in the 1960s, and they are inconsistent in their conclusions. In many instances, studies failed to describe the subject’s level of motor involvement or intelligence. There has been a wide range in ages of subjects used in this research. Many studies have used both right- and left-hemiplegic subjects but have not examined visual-perceptual deficits in diplegic subjects. In addition, many studies which purported to assess visual perception used evaluations that required a skilled motor response (Bortner & Birch, 1962; Newcomer & Hammill, 1973; Wedell, 1960).

Occupational therapists are frequently the designated professionals responsible for assessing and treating visual-perceptual skills in children with CP. The use of standardized tests aids in identifying specific visual perceptual deficits, and these tests are a necessary part of the evaluation of the child with CP. The results of visual-perceptual testing have implications for treatment and for the performance of cognitive, communicative, and activities-of-daily-living tasks. Further knowledge of the visual-perceptual functioning of the child with CP that lead to more appropriate evaluations may enable the occupational therapist to develop better remediation strategies.

Since occupational therapists are involved with the visual-perceptual habilitation of the child with CP, the evaluation measures used by the occupational therapist need to be studied. The purpose of this investigation was to determine if there were differences in performance between normal children and children with CP in visual perception not requiring a skilled motor response. It was hypothesized that the group with CP would obtain significantly lower scores than the normal control (NC) group. A secondary purpose of this study was to descriptively examine whether the performance of children with different types of CP differs on a test of visual perception. The test used in this project was the Test of Visual-Perceptual Skills (TVPS) (Gardner, 1982). The TVPS was selected for this study because it appears to be a comprehensive motor-free evaluation of visual perception for children. The 112-item test is divided into seven subtests of visual perception: visual discrimination, visual memory, perception of visual-spatial relationships, perception of visual form constancy, visual sequential memory, visual figure-ground perception, and visual closure (see Appendix for definitions of these terms). Each subtest includes 16 items presented in increasing order of difficulty. The TVPS was standardized on 1,000 children, ages 4 years to 12 years and 11 months (approximately 100 children each at ages 4, 5, 6, 7, 8, 9, 10, 11, and 12 years). The TVPS provides the examiner with scaled scores of the subtests, percentile rank and perceptual age for each subtest, a perceptual quotient, and an overall percentile rank. Although the Motor-Free Visual Perception Test (MVPT) by Colarusso and Hammill (1972) also assesses a variety of visual-perceptual skills and does not have a motor component, the age range of the MVPT is more limited (4 to 8 years), and scores are not provided for the individual subtests.

Method

Subjects. The CP group consisted of 24 children: 6 were diplegic, 14 were quadriplegic, and 4 were spastic-athetoid quadriplegic. The availability of CP subjects who met the criteria for this study was limited. Approximately an additional 20 children were considered but excluded from this study because their verbal IQs were less than 80. Twenty-four normal children were used as the control group. There were 15 boys and 9 girls each in the CP and the NC.

Table 1
Means, Standard Deviations, and Range of Age for Each Group

<table>
<thead>
<tr>
<th>Group</th>
<th>Age (Months)</th>
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<tbody>
<tr>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>Normal control</td>
<td>121.2</td>
</tr>
<tr>
<td>Cerebral palsy (CP) total</td>
<td>125.5</td>
</tr>
<tr>
<td>CP 1</td>
<td>128.8</td>
</tr>
<tr>
<td>CP 2</td>
<td>115.8</td>
</tr>
<tr>
<td>CP 3</td>
<td>125.3</td>
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Note. CP 1 = Spastic/athetoid quadriplegia, n = 4. CP 2 = Spastic diplegia, n = 6. CP 3 = Spastic quadriplegia, n = 14.
groups. Ages ranged from 9 to 12 years. The mean and standard deviation age in months for the CP group and the NC group are reported in Table 1. There were no significant differences in age between the two groups ($t = .47, p = .64$).

All CP children had a medical diagnosis of CP and sustained the brain lesion prior to or during birth. All CP children were of normal intelligence, which was defined as having a verbal IQ of 80 or more on the WISC-R (Wechsler, 1974). Intelligence quotients were not available for the normal group, but all children were assumed to be of normal intelligence since they were achieving normally in school. The children were recruited from the Boston, Massachusetts, and Providence, Rhode Island, areas. The majority of the subjects with CP attended private schools for the physically disabled, including Meeting Street School, Providence, Rhode Island; Massachusetts Hospital School, Canton, Massachusetts; and Cotting School for the Physically Handicapped, Boston. No subject had received the TVPS in the previous 6 months.

*Instrument.* The TVPS (Gardner, 1982) is a relatively new instrument. The examination of the instrument's psychometric properties has only begun. The reliability of the TVPS was established by examining the internal consistency of the subtests and the test as a whole. Reliability for subtests was calculated with Cronbach's coefficient alpha, with the median reliability across ages for the seven subtests ranging from .66 to .80. Reliability for the test as a whole (based on the perceptual quotient) was calculated with a formula for composite scores. The median reliability across ages was .90. Test-retest reliability has not yet been examined.

During the development of the TVPS, its validity as an instrument for assessing visual perception was examined. Item validity was established as follows: Items selected for the final form met the criteria of item discrimination as measured by item correlations with subtest and total test scores and correlations with chronological age. Furthermore, the relationship of item order to item difficulty was calculated using Spearman rank order correlation, with a range from $- .90$ to $-.99$ (median $-.98$) indicating that items are generally arranged in order of increasing difficulty.

To establish the diagnostic validity of the test, subtest intercorrelations were examined to determine whether each subtest was measuring a unique aspect of behavior. High subtest intercorrelations indicate that the subtests are measuring similar facets of behavior and are therefore redundant; low subtest intercorrelations indicate that each subtest is measuring a unique aspect of behavior. The median subtest intercorrelations across age groups ranged from .18 to .40. The subtest/total correlations ranged from .54 to .65 (overall median .63), indicating that each subtest assesses a unique aspect of visual perception that contributes to the variance of the total TVPS.

To further examine the diagnostic validity of the TVPS Gardner compared a sample of learning-disabled (called "learning handicapped" in the study) students ($n = 45$) with a matched sample from the standardization sample. The performance of the learning-disabled students was significantly lower than the performance of the normative sample. To date, this test has not been used to compare the performance of children with CP with the performance of a matched normal sample.

Gardner identified the following advantages of the TVPS: The test does not require a verbal response, the forms are not language related, and the speed of a child's selection does not affect performance. According to Gardner, occupational therapists, teachers, and psychologists are among the professionals for whom this test may be useful. Advanced training is not required to administer the TVPS.

*Procedure.* The TVPS was individually administered to each subject in the standardized manner described in the test manual (Gardner, 1982). The TVPS is not a timed test. Instead, the child's performance determines the length of administration. Each subtest is started with the first test item and ended when the child reaches the ceiling for that subtest. A ceiling is defined as the moment when a child of any age has three failures on four consecutive items on a subtest with four choices, or four failures on five consecutive items on a subtest with five choices. It takes approximately 30 to 45 minutes to administer the test to one child. Each child was seated while taking the test, with the test plates lying flat on a table placed directly in front of the child. The child answered test questions by pointing to the answer, giving a verbal response, or using a communication board. The examiner recorded the child's performance on a recording form included with this test. The raw scores were then converted to scaled scores, perceptual quotient, and percentile rank.

*Results.* It was hypothesized that the CP group would obtain significantly lower scores than would the NC group. Therefore, a $t$ test was used to determine if there was a significant difference between the two groups' mean scores for perceptual quotient. The mean, standard deviation, and range of scores for the CP and NC groups are presented in Table 2. Results of the one-tailed $t$ test indicated that there were significant differences in perceptual quotients between the NC and CP groups ($t = 12.60, p < .001$). In addition, the
The results of this study support the hypothesis that children with CP will obtain significantly lower scores on a motor-free test of visual perception. All but one subject in the CP group fell more than one standard deviation below the mean of the normal sample. While all three CP groups scored lower than the normal controls, the spastic quadriplegic group scored lowest on six of seven subtests. However, the wide variability of scores between the three groups resulted in differences that were not statistically significant. To further study differences between these subgroups, larger numbers of subjects are needed. Further study is needed to determine what differences do exist between different subgroups of children with spastic CP and children with athetoid CP.

This study indicated that the TVPS may be a useful evaluation tool for children with CP. However, because of the small number of CP subjects used in this study, the results may not be indicative of visual perceptual functioning in all CP children. Further study of visual perceptual functioning in all ages of CP children would provide much needed information on the development of visual perception in children with CP.

Table 2
Means, Standard Deviations, and Range of TVPS Perceptual Quotients for Each Group

<table>
<thead>
<tr>
<th>Group</th>
<th>Perceptual Quotient</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Normal control</td>
<td>131</td>
<td>15.5</td>
</tr>
<tr>
<td>Cerebral palsy</td>
<td>68.8</td>
<td>18.6</td>
</tr>
</tbody>
</table>

Note: TVPS = Test of Visual-Perceptual Skills (Gardner, 1982).

Discussion

The results of this study support the hypothesis that children with CP will obtain significantly lower scores than normal children on a motor-free test of visual perception. All but one subject in the CP group fell more than one standard deviation below the mean of the normal sample. While all three CP groups scored lower than the normal controls, the spastic quadriplegic group scored lowest on six of seven subtests. However, the wide variability of scores between the three groups resulted in differences that were not statistically significant. To further study differences between these subgroups, larger numbers of subjects are needed. Further study is needed to determine what differences do exist between different subgroups of children with spastic CP and children with athetoid CP.

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Table 3
Means and Standard Deviations of TVPS Total Test and Subtests Scaled Scores by Group

<table>
<thead>
<tr>
<th>Subtest</th>
<th>NC Mean</th>
<th>CP Mean</th>
<th>CP 1* (n = 4)</th>
<th>CP 2** (n = 6)</th>
<th>CP 3*** (n = 14)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Test</td>
<td>99.87</td>
<td>39.88</td>
<td>44</td>
<td>49</td>
<td>34.64</td>
</tr>
<tr>
<td></td>
<td>14.60</td>
<td>17.46</td>
<td>12.28</td>
<td>23.87</td>
<td>12.85</td>
</tr>
<tr>
<td></td>
<td>56-127</td>
<td>12-93</td>
<td>29-63</td>
<td>19-95</td>
<td>12-67</td>
</tr>
</tbody>
</table>

Note: TVPS = Test of Visual-Perceptual Skills (Gardner, 1982). NC = normal control group. CP = cerebral palsy group.

* Spastic/athetoid quadriplegia. ** Spastic diplegia. *** Spastic quadriplegia.
Intelligence scores were not available for the normal subjects, and there is a possibility that these children could be bright for their age groups. The mean perceptual quotient on the TVPS for the normal subjects was 131, which is two standard deviations below the mean perceptual quotient of the normative sample. Verbal intelligence scores for the CP subjects allowed access to specific scores which were considered confidential. Instead, the psychologist at the child’s school reviewed the records and only reported whether the child met the minimum, cut-off scores of ≥80. Therefore, there may be a difference in IQ scores between the CP and the normal subjects, but it does not seem as though this would have been great enough to account for the difference in perceptual quotient scores between the two groups.

Conclusion

The results of this study indicate that there are significant differences between normal children and children with CP in performance on the TVPS. This study supports previous research which found visual-perceptual deficits in the children with CP. The TVPS appears to be an evaluation tool that may prove to be valuable to the occupational therapist as a means of determining visual perceptual functioning in the child with CP.

Continued research is needed to examine visual-perceptual development and functioning in the child with CP. This study would be strengthened by increasing the number of subjects studied and by specifically matching the CP and NC groups in terms of IQ. Additional research to examine differences in visual-perceptual functioning in CP subgroups would be useful in determining differences between these groups. A comparison of motorfree visual-perceptual tests would aid the occupational therapist in determining the most appropriate evaluation for clients with CP. In addition, a comparison of visual-perceptual and perceptual-motor tests with CP clients is needed to update previous research.

Acknowledgments

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Appendix

Description of TVPS Subtests

Visual Discrimination
Match two forms when one of the forms is among similar forms.

Visual Memory
Remember (after 4 or 5 seconds) and find a form from an array of similar forms.

Visual-Spatial Relationships
Determine, from among five forms of identical configuration, the one single form or part of a single form that is going in a direction different from the other forms.

Visual Form Constancy
See a form and find it, even though it may be smaller, larger, rotated, reversed, or hidden.

Visual Sequential Memory
Remember (after 4 or 5 seconds) a series of forms from among four separate series of forms.

Visual Figure–Ground
Find a form hidden in a conglomerated ground of matter.

Visual Closure
Determine, from among four incomplete forms, the one that is the same as the completed stimulus form.


References


