The Relationship Between Visual-Perceptual Motor Abilities and Clumsiness in Children With and Without Learning Disabilities

Valerie O'Brien, Sharon A. Cermak, Elizabeth Murray

Key Words: dyspraxia • sensory integration • visual perception

Many occupational therapists treat children with learning disabilities for visual-perceptual problems, visual-motor problems, and motor incoordination. Some researchers suggest that visual-perceptual deficits are characteristic of children with learning disabilities (Bush & Waugh, 1982). Others say that children with learning disabilities have average to superior visual-perceptual skills (Geschwind & Galaburda, 1985). Because people with learning disabilities form a heterogeneous group, it is probable that there are subgroups of children with learning disabilities who do have and who do not have visual-perceptual problems. Rourke (1985) has emphasized that

the confusion that abounds in the literature dealing with the group of clinical problems known as learning disabilities is, in many ways, a direct reflection of the failure of many scientists and practitioners in this field to acknowledge and address the heterogeneity and diversity existing among the learning disabled population. (p. vii)

He emphasizes the need to examine subtypes of learning disabilities.

In addition to visual-perceptual problems, non-specific awkwardness or clumsiness, though not specific to children with learning disabilities, appears in greater numbers of these children than in children without such disabilities. Researchers have estimated that between 5% and 18% of school-age children may...
have motor problems (Brenner, Gilman, Zangwill, & Farrell, 1967; Gubbay, 1978; Henderson & Hall, 1982). These children form a heterogeneous group; all show some degree of inability in their performance of skilled or complicated motor tasks. Problems in the motor performance of children with learning disabilities have been noted as far back as 1937 when Orton (1937) described abnormal clumsiness in many of the children that he studied. Strauss and Lehtinen (1947) discussed the incoordination that frequently occurs in brain-injured children. Researchers in the 1960s began to delineate this clumsiness, or developmental dyspraxia, evident in many children with learning disabilities (Gubbay, Ellis, Walton, & Court, 1965; Kephart, 1960; Walton, Ellis, & Court, 1963).

The terms developmental dyspraxia or clumsy have been used to label children with a motor planning problem. Gubbay (1985) described the clumsy child as one "whose ability to perform skilled purposive movement is impaired, yet whose motor coordination is virtually normal by the standards of routine, conventional neurological assessment and who also has normal bodily habits, intellect, physical strength and sensory function" (p. 159). Ayres (1979) noted that the clumsy child seems to have "less of a sense of his body and what it can do" (p. 101).

Clinical manifestations appear to be varied. General awkwardness, poor tactile perception abilities, inadequate body scheme, delayed acquisition of daily living skills, poor gross and fine motor skills, and articulation deficits are a number of characteristics frequently attributed to the dyspraxic child (Ayres, 1979; Cermak, 1985; Knuckey, Apsimon, & Gubbay, 1983).

Visual-perceptual and visual-motor deficits have been described as two of the many performance deficits associated with the clumsy child with learning disabilities. These components are particularly relevant because some researchers have suggested that visual-perceptual and visual-motor difficulties underlie the clumsiness seen in some children with learning disabilities (Henderson & Hall, 1982; Hulme, Biggerstaff, Moran, & McKinley, 1982). Hulme, Biggerstaff, Moran, and McKinley studied 16 clumsy and 16 normal children in a task of matching the length of lines between and within the modalities of vision and kinesthesia. These researchers found that the visual condition and motor performance correlated highly. Although adequate kinesthetic sense was described to be necessary to discriminate body position and amplitude of movement, kinesthetic and intersensory conditions did not correlate with motor ability. In a follow-up study (Hulme, Smart, & Moran, 1982) results continued to reveal increased visual-perceptual deficits in clumsy children. The authors suggested that visual-perceptual problems may be a cause of clumsiness.

Ayres (1985) also found that many dyspraxic children had visual-perceptual problems. However, she theorized that visual perception is an end product and not the basis for the clumsiness. Because factor analytical studies showed that performance on tactile tests significantly correlated with motor planning abilities (Ayres, 1966, 1969), Ayres (1969) suggested that tactile perceptual deficits may be a factor in the clumsiness.

The present study was designed to further examine the relationship between visual-perceptual and visual-motor deficits and clumsiness in the child with learning disabilities. It was hypothesized that clumsy children with learning disabilities would score significantly lower on visual-perceptual and visual-motor tests than nonclumsy children with learning disabilities, and that nonclumsy children with learning disabilities would score significantly lower than children without learning disabilities. It was further hypothesized that there would be a significant correlation between the degree of clumsiness and the degree of visual-perceptual and visual-motor deficit in the subjects with learning disabilities.

Method

Subjects

Forty-four children participated in the study. Twenty-two had learning disabilities (age range 5 years to 8 years 10 months) and the remaining 22, who had no learning disabilities, served as a control group (age range 5 years 6 months to 8 years 11 months). The children were matched as closely as possible for age and sex. Thirty-two of the subjects were male (16 with disabilities, 16 without) and 12 were female (6 with disabilities, 6 without).

The children participating in the study attended public and private schools within the Greater Boston area. Each child in the control group was in an age-appropriate grade and had no special education requirements and no history of receiving remedial help. Each child in the experimental group had a diagnosed learning disability and was receiving special services for his or her specific disability. The children with learning disabilities (the LD group) were divided into two groups—"clumsy" and "nonclumsy"—based on their scores on the Test of Motor Impairment (Stott, Moyes, & Henderson, 1984). Of the LD group, 13 were classified as clumsy and 9 as nonclumsy. It should be noted that 3 subjects in the control group scored in the mild-clumsy range and the rest scored in the nonclumsy range. (See Tables 1 and 2 for a description of subject groups.)
The American Journal of Occupational Therapy

Table 1
Description of Subjects

<table>
<thead>
<tr>
<th>Age</th>
<th>Control Group</th>
<th>Children With Learning Disabilities</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Clumsy</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Male</td>
<td>Female</td>
<td>Male</td>
</tr>
<tr>
<td>5</td>
<td>10</td>
<td></td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>11</td>
<td></td>
<td>6</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>12</td>
<td></td>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>8</td>
<td>11</td>
<td></td>
<td>4</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

Procedure

One visual-perceptual test, four visual-motor tests, and the Test of Motor Impairment (TMI) were administered to each child by the same examiner in a session lasting 1 to 1 1/2 hours. The children were tested either at their homes or at the Boston University Occupational Therapy Clinic.

The series of tests, which was administered according to the directions in the test manual for each test, was given in the following order for each child:

1. Developmental Test of Visual Motor Integration, Revised (Beery & Buktenica, 1980). This test contains a series of 24 geometric forms that are to be copied with pencil in the protocol book. Normed on 2- to 15-year-olds, it is used to assess visual-motor integration. A visual-motor age-equivalent score is obtained based on the number of correct forms completed up to three consecutive failures. In addition to the age-equivalent score, a visual-motor age difference score, reported in months, was computed for use in this study by subtracting the child's chronological age from his or her obtained visual-motor age-equivalent score.

2. Raven Progressive Matrices (Raven, 1960). This scale consists of 60 problems divided into five sets of 12. The problems are meaningless figures that require observation, derivation of relationships between the figures, and reasoning to complete each figure. The test is suitable for ages 6 years to adult. A percentile score, obtained by extrapolation for the 5-year-olds, was used. This test was considered a measure of visual perception.

3. Block Design (Wechsler, 1974). This subtest of the Wechsler Intelligence Scale for Children, Revised, requires reproduction of a presented two-dimensional design by block manipulation. The test is standardized on 6- to 16-year-olds. Scaled scores were used, with scores extrapolated for the 5-year-olds.

4. Primary Visual Motor Test (Haworth, 1970). This test consists of 16 designs, shown one at a time, that the child is required to copy. Suitable for 4- to 8-year-olds, it is used to assess visual-motor development and to evaluate deviation in visual motor functioning. Raw scores, the total number of errors, and category scores (impaired, or average to above average) were used in data analysis.

5. Rey-Osterrieth Complex Figure Test (Waber & Holmes, 1985). This test, recently described in a format for children, requires the child to reproduce a complex design using five different colored pencils in a specified time limit. An organization score based on the correct features drawn in the design was recorded in standard deviation scores.

6. Test of Motor Impairment (TMI) (Stott, Moyes, & Henderson, 1984). This screening test is designed to measure the degree of motor impairment in children aged 5 years and up. Children are given a series of 8 tasks at their age range that evaluate manual dexterity, static balance, dynamic balance, and ball skills. Scores are interpreted as 0 to 3.5—no impairment, 4.0 to 5.5—mild to moderate impairment, and above 6.0—definite impairment. For the purposes of this study, 0 to 3.5 was considered normal and scores 4.0 and above were considered impaired, or clumsy.

Results

In order to test the hypothesis that clumsy children with learning disabilities will score significantly lower on the visual-perceptual and visual-motor tests than nonclumsy children with learning disabilities, and that nonclumsy children with learning disabilities will score significantly lower than children without learning disabilities, one-way between group (clumsy LD, nonclumsy LD, and control) analyses of variance (ANOVA) on each dependent measure were performed. The means and standard deviation for each group on each test as well as the F values of the ANOVAs are presented in Table 3. As noted in this table, there were between-group differences on each of the visual-perceptual and visual-motor tests. Scheffe multiple comparisons were performed to see where the differences were. A consistent pattern was found, with significant differences on each measure between the control group and the clumsy LD group but no other significant between-group differences.

In order to test the hypothesis that there would
Table 3
Scores on the Visual-Perceptual Motor Tests for Children With and Without Learning Disabilities

<table>
<thead>
<tr>
<th>Test</th>
<th>Control Group</th>
<th>Children With Learning Disabilities</th>
<th>ANOVA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Clumsy</td>
<td>Nonclumsy</td>
</tr>
<tr>
<td>Visual Motor Integration</td>
<td>X</td>
<td>97.32</td>
<td>72.46</td>
</tr>
<tr>
<td>(age equivalent, months)</td>
<td>SD</td>
<td>30.78</td>
<td>24.70</td>
</tr>
<tr>
<td>Raven Matrices</td>
<td>X</td>
<td>94.09</td>
<td>76.61</td>
</tr>
<tr>
<td>(percentile score)</td>
<td>SD</td>
<td>11.16</td>
<td>23.76</td>
</tr>
<tr>
<td>WISC-R Block Design</td>
<td>X</td>
<td>13.77</td>
<td>9.00</td>
</tr>
<tr>
<td>(scale score)</td>
<td>SD</td>
<td>3.25</td>
<td>3.94</td>
</tr>
<tr>
<td>Primary Visual Motor</td>
<td>X</td>
<td>12.91</td>
<td>28.54</td>
</tr>
<tr>
<td>(raw error score)</td>
<td>SD</td>
<td>9.99</td>
<td>19.56</td>
</tr>
<tr>
<td>Rey-Osterrieth Complex Figure</td>
<td>X</td>
<td>0.21</td>
<td>-0.86</td>
</tr>
<tr>
<td>(SD score)</td>
<td>SD</td>
<td>1.33</td>
<td>0.56</td>
</tr>
</tbody>
</table>

* p < .05. **p < .01.

be a significant correlation between the degree of clumsiness and the degree of visual perceptual and visual-motor deficit in children with learning disabilities, a Spearman rank order coefficient of correlation was used. Significant correlations (p < .05) were obtained between the TMI score and the visual-perceptual test (Raven Progressive Matrices) as well as between the TMI and two of the three visual-motor tests (see Table 4). A point-biserial correlation was used to examine the correlation between the TMI and the Primary Visual Motor Test because the scores on the Primary Visual Motor Test result in placement in either the impaired or the average-to-above-average category. A significant correlation, r = -0.44 (t = -(2.40), p < .05), was found, supporting the hypothesis.

Discussion

The hypothesis that clumsy children with learning disabilities will score significantly lower on visual-perceptual and visual-motor tests than nonclumsy children with learning disabilities and that nonclumsy children with learning disabilities will, in turn, score significantly lower than children without learning disabilities was only partially supported. For all visual-perceptual and visual-motor measures, the children in the clumsy LD group scored significantly lower than the children in the control group, but the difference between the nonclumsy LD group and the control group and between the two LD groups—clumsy and nonclumsy—was not significant.

One interpretation of the results is that there are indeed subgroups of learning disabilities, and one way of categorizing these subgroups is based on motor competence. Mean scores for all tests were best in the control group and worst in the clumsy LD group, indicating a trend in scores. It may be that there was a difference between the nonclumsy and the clumsy LD group, but, because of the small sample size, the difference was not perceptible. The results do suggest that visual-perceptual abilities are

Table 4
Correlations Between TMI, VMI, Raven, WISC-R Block, and Rey-Osterrieth Tests for Children With Learning Disabilities (N = 22)

<table>
<thead>
<tr>
<th>TMI</th>
<th>VMI</th>
<th>Raven Matrices</th>
<th>WISC-R Block Design</th>
<th>Rey-Osterrieth Complex Figure</th>
</tr>
</thead>
<tbody>
<tr>
<td>TMI: No. of errors</td>
<td>-</td>
<td>-400*</td>
<td>-395*</td>
<td>-407*</td>
</tr>
<tr>
<td>VMI age difference score*</td>
<td>-</td>
<td>-</td>
<td>.438*</td>
<td>.620**</td>
</tr>
<tr>
<td>Raven Matrices percentile score</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>.451*</td>
</tr>
<tr>
<td>WISC-R Block Design scale score</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Rey-Osterrieth Complex Figure SD score</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Note. TMI = Test of Motor Impairment. VMI = Developmental Test of Visual Motor Integration. WISC-R = Wechsler Intelligence Scale for Children, Revised.

*VMI age difference score obtained by subtracting chronological age from VMI age-equivalent score.

*p < .05. **p < .01.
clearly not superior in people with learning disabili-

ties, as was proposed by Geschwind and Galaburda

(1985).

Degree of clumsiness did appear, indeed, to be

significantly related to the degree of visual-perceptual

and visual-motor deficit in that the clumsier the child

was the greater was the visual-perceptual and visual-

motor problem. Whether the clumsiness is the result

of visual-perceptual and visual-motor deficits, as sug-

gested by some researchers (Henderson & Hall, 1982;

Hulme, Biggerstaff, Moran, & McKinley, 1982;

Hulme, Smart, & Moran, 1982), or whether the visual-

perceptual and visual-motor difficulties and clumsi-

ness all are the result of tactile and kinesthetic pro-

cessing dysfunction, as noted by Ayres (1966, 1969,

1979, 1985), remains unclear and will be explored in

a future study. Further examination of the relationship

between these factors is needed because this relation-

ship would appear to have implications for the

treatment of the clumsy child with learning disabili-

ties. For example, if the underlying problem involves

an impairment in tactile and kinesthetic processing,

then treatment would be aimed at improving sensory

processing, and procedures such as sensory integra-

tion would be emphasized. On the other hand, if the

problem underlying the child’s clumsiness is visual-

perceptual in nature, then remediation might focus

on visual-spatial analysis and/or activities involving

the integration of visual and motor components of

performance. As yet, the causative relationship is

speculative.

References

Ayres, A. J. (1966). Interrelationships among percept-

ual-motor functions in children. American Journal of Oc-

cupational Therapy, 20, 68–71.

Ayres, A. J. (1969). Deficits in sensory integration in

educationally handicapped children. Journal of Learning


Los Angeles: Western Psychological Services.

Ayres, A. J. (1985). Developmental dyspraxia and

adult-onset apraxia. Torrance, CA: Sensory Integration

International.

Beery, K., & Buktenica, M. (1980). Developmental Test


Brenner, M. W., Gilman, S., Zangwill, O. L., & Farrell,


Medical Journal, 4, 259–262.

ing problems. Columbus, OH: Charles Merrill.


E. A. Roy (Ed.), Neuropsychological studies of apraxia and

related disorders (pp. 225–243). Amsterdam: Elsevier.

Geschwind, N., & Galaburda, A. M. (1985). Cerebral


Gubbay, S. S. (1978). The management of develop-
mental dyspraxia. Developmental Medicine and Child Neu-

rology, 20, 448–460.


G. W. Bruyn, & H. L. Klawans (Eds.), Handbook of clinical


Gubbay, S. S., Ellis, T., Walton, J. N., & Court, S. D. M.


York: Grune & Stratton.


clumsiness in young schoolchildren. Developmental Medi-

Hulme, C., Biggerstaff, A., Moran, G., & McKinley, I.

(1982). Visual, kinesthetic and cross-modal judgements of

length by normal and clumsy children. Developmental Medi-
cine and Child Neurology, 24, 461–471.

Hulme, C., Smart, S., & Moran, G. (1982). Visual per-
ceptual deficits in clumsy children. Neuropsychologia, 4,

475–481.


Columbus, OH: Charles Merrill.

Knuckey, N. W., Apsimon, T. T., & Gubbay, S. S.


with developmental apraxia and agnosia. Brain and Devel-
opment, 5, 14–20.

Orton, S. T. (1937). Reading, writing and speech


Rourke, B. P. (1985). Neuropsychology of learning dis-

abilities: Essentials of subtype analysis. New York: Guilford

Press.


Manual of Test of Motor Impairment—Henderson Revision.

Ontario: Brook Educational.

Strauss, A. A., & Leibenin, L. E. (1947). Psychopathol-
yogy and education of the brain-injured child. New York:

Grune & Stratton.

Waber, D. P., & Holmes, J. M. (1985). Assessing chil-

dren’s copy productions of the Rey-Osterrieth Complex Fig-

ure. Journal of Clinical and Experimental Neuropsychol-
yogy, 7, 264–280.


Clumsy children: Developmental apraxia and agnosia.

Brain, 85, 603–612.
