The Validity of the Constructional Subtests of the Sensory Integration and Praxis Tests

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Key Words: learning disorders • reliability of tests • tests, by title, Sensory Integration and Praxis Tests • visual perception

This study was designed to examine the validity of the Design Copying and Constructional Praxis subtests of the Sensory Integration and Praxis Tests (SIPT) (Ayres, 1989) through an examination of convergent validity and the use of contrast groups. The subjects were 39 children aged 5 to 8 years. Of these children, 21 had learning disabilities and 18, who served as the control group, had no learning disabilities. The subjects were administered the SIPT as well as four other standardized measures of constructional abilities: the Developmental Test of Visual-Motor Integration (Beery, 1980), the Block Design subtest of the Wechsler Intelligence Scale for Children—Revised (Wechsler, 1974), the Primary Visual Motor Test (Haworth, 1970), and the Rey-Osterrieth Complex Figure Test (Waber & Holmes, 1985). The results indicated that the children with learning disabilities performed significantly more poorly than did the control subjects on both the Design Copying and Constructional Praxis subtests. These two subtests showed moderately high correlations (.46 to .71) with the other tests of constructional abilities when both groups were combined. Correlations were mostly in the moderate range for the children with learning disabilities but were generally not significant for the control sample. The results are discussed in terms of task demands and subject variability.

Constructional abilities are defined as those abilities that allow a person to put parts together or to articulate them to form a single entity or object (Heilman & Valenstein, 1985). They require the ability to accurately perceive the spatial relations among component parts in order to synthesize these parts into a whole (Benton, 1979; Heilman & Valenstein, 1985; Lezak, 1983). Deficits in constructional abilities were first described in patients with brain injuries who demonstrated what was originally called constructional apraxia. The term constructional apraxia was used by Kleist in 1923 (Benton, 1979) to describe patients with adequate visual perception who could not translate this perception into action. Kleist considered the disability in these patients to be one of motor execution rather than of visual perception. The use of the term broadened, however, and emphasis was later placed on the visuospatial aspects of the disability rather than on the motor component (Benton, 1979; Hecaen & Assal, 1970). More recently, it has been suggested that the term constructional abilities, or visuoconstruction, may more appropriately describe these skills (Cermak, 1984; Lezak, 1983; Murray, in press).
Assessment of constructional abilities involves two major types of activities: drawing tasks and assembly tasks (Benton, 1979). Drawing tasks involve both copying and free drawing (e.g., drawing a bicycle from a model and from memory). Assembly tasks involve three-dimensional construction (e.g., copying a train made out of 1-in. cubes) and two-dimensional construction (e.g., putting together a puzzle). Although all of these tasks require the assembling of parts into an unitary whole, both the perceptual and motor demands vary. For example, drawing tasks rely more heavily on fine motor skills than do block constructions. Additionally, the tasks may require a person to produce a structure on verbal command, to imitate or copy from a model, or to reproduce a model from memory (Cermak & Murray, 1990).

Two subtests of the SIPT—Design Copying and Constructional Praxis—measure constructional abilities. The Design Copying subtest is a drawing task that requires the child to copy increasingly complex designs. It consists of two parts: Part 1 requires the copying of designs on a dot grid, and Part 2 consists of the copying of designs without a dot grid. The score indicates the accuracy of the child’s drawings.

The Constructional Praxis subtest is an assembly task that assesses skill in relating objects to each other through building two different three-dimensional structures with blocks. For Structure 1, the child first watches as the examiner builds a model, then duplicates the examiner’s model. For Structure 2, the child duplicates a preassembled model. Despite the name of this test, the scoring criteria emphasize the spatial aspect of the task (i.e., relating the parts to the whole) rather than motor execution.

Because the SIPT is relatively new, it is important that we examine its psychometric properties. Reliability was reported in the test manual (Ayres, 1989). Test–retest reliability for a sample of learning-disabled and non-learning-disabled children was .95 for Design Copying and .70 for Constructional Praxis. Interrater reliability was .97 for Design Copying and .98 for Constructional Praxis. Validity is often considered the single most important aspect of test development (Anastasi, 1988), but it is the most difficult to establish. It is usually accomplished through numerous studies conducted over time rather than through a single study. “The ultimate validity of a test can never be proven. Rather, ongoing use of an instrument contributes to accumulated evidence of its validity” (Dunn, 1989, p. 153).

The three major types of validity are content validity, criterion validity, and construct validity. The present study was designed to examine the third category, construct validity.

Construct validity is the extent to which a particular test can be shown to measure a hypothetical construct or trait (Anastasi, 1988). A construct is a theoretical idea developed to explain and organize some aspects of existing knowledge. Intelligence, creativity, and sensory integration are all examples of constructs. In the present study, the construct being addressed is constructional abilities. Constructional abilities imply an organizing activity in which the spatial relations among the component parts must be accurately perceived in order to synthesize the parts into a whole (Heilman & Valenstein, 1985).

Construct validity is best established when a test correlates substantially with variables with which it theoretically should correlate (convergent validity) (Anastasi, 1988). Moderately high correlations with other tests that purport to measure the same construct are evidence that the new test measures the same areas of behavior as the other tests. Correlations should be moderately high but not too high. If the new test correlates too highly with an already available test, it may be measuring the same construct as the existing test and therefore may represent needless duplication, unless the new test has advantages, such as ease of administration or brevity.

In the present study, we examined the relation between learning-disabled and non-learning-disabled children’s scores on the two constructional subtests of the SIPT with performance on four other standardized tests of constructional abilities. We hypothesized that there would be significant and moderately high correlations (.50 to .70) between scores on the Design Copying and Constructional Praxis subtests of the SIPT and each of four standardized measures of constructional abilities: the Primary Visual-Motor Test (Haworth, 1970), the Developmental Test of Visual-Motor Integration (Beery, 1980), the Block Design subtest of the Wechsler Intelligence Scale for Children—Revised (WISC–R) (Wechsler, 1974), and the Rey-Osterrieth Complex Figure Test (Waber & Holmes, 1985).

Another method by which to examine validity is through the use of contrast groups. If a significant difference in performance can be found between two groups known to differ on a variety of related measures, then evidence of test validity is provided. In the present study, we examined whether the learning-disabled and non-learning-disabled children would score differently on the constructional subtests of the SIPT. We hypothesized that the children with learning disabilities would score significantly more poorly than would the non-learning-disabled control group on the Design Copying and Constructional Praxis subtests of the SIPT.

Method

Subjects

Thirty-nine children participated in this study. Twenty-one subjects had learning disabilities (mean age = 6 years 9 months, SD = 12.0 months, range = 5 years 4 months to 8 years 7 months), and 18 subjects, who served as the control group, were without learning disabilities.
(mean age = 6 years 11 months, SD = 14.9 months, range = 5 years 1 month to 8 years 10 months).

The children participating in this 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 learning-disabilities group had a learning disability and was receiving special education services for his or her specific disability.

Procedure

All children were seen individually, either at their homes or at the Boston University Occupational Therapy Clinic. During the first session, we administered the Design Copying and Constructional Praxis subtests according to standardized instructions (Ayres, 1989). Scores for both of these tests are reported in standard deviation units.

The other tests of constructional abilities were administered in the following session by a registered occupational therapist who was a graduate student at Boston University. Three of these tests are drawing tests, and one is a two-dimensional assembly test.

Developmental Test of Visual-Motor Integration, Revised. This test contains a series of 24 geometric forms that are to be copied with a pencil in the protocol book. A visuomotor age-equivalent score was obtained on the basis of the number of correct forms completed, up to three consecutive failures. In addition to the age-equivalent score, a visuomotor age-difference score, reported in months, was computed for use in this study by the subtraction of the child's chronological age from his or her obtained visuomotor age-equivalent score.

Block Design. This subtest of the WISC-R requires reproduction of a presented two-dimensional design by block manipulation. The test is standardized for 6- to 16-year-olds. Scaled scores were used, with scores extrapolated for the 5-year-olds.

Primary Visual Motor Test. This test consists of 16 designs, shown one at a time, which the child is required to copy. Raw scores (the total number of errors) and category scores (impaired, or average to above average) were used in data analysis.

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

Results

To examine the first hypothesis, that there would be moderately high correlations between the SIPT constructional subtests and the other standardized measures of constructional abilities, we computed Pearson correlation coefficients for the scores on the Design Copying and the Constructional Praxis subtests and each of the other tests of constructional abilities, first for the learning-disabled and control subjects combined, and then for each group separately (see Table 1). Correlations were moderately high for the combined sample. When the samples were examined separately, correlations were moderately high for the children with learning disabilities but lower for the control group.

To examine whether the children with learning disabilities performed significantly more poorly than the control subjects on the constructional subtests of the SIPT, between-groups t tests were computed. The t tests (with the use of pooled variance) indicated a significant between-groups difference on the Design Copying subtest, t (df = 37) = 5.02, p < .01, and on the Constructional Praxis subtest, t (df = 37) = 6.25, p < .01. Table 2 shows the means and standard deviations for each group. As hypothesized, the children with learning disabilities performed significantly more poorly than did the non-learning-disabled children.

Discussion

The results of this study support the hypothesis that there would be moderately high correlations between the Design Copying and Constructional Praxis subtests and other standardized measures of constructional abilities. This must be qualified, however, in that correlations were moderately high for the combined sample and for the learning-disabled sample. Correlations, however, were negligible for the non-learning-disabled sample.

Table 1

<table>
<thead>
<tr>
<th>SIPT Subtest</th>
<th>VMI</th>
<th>Block Design</th>
<th>Primary Visual Motor Test</th>
<th>Rey-Osterrieth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Combined Sample (N = 39)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design Copying</td>
<td>.67***</td>
<td>.71***</td>
<td>.65***</td>
<td>.52**</td>
</tr>
<tr>
<td>Constructional Praxis</td>
<td>.67***</td>
<td>.61***</td>
<td>.58***</td>
<td>.46***</td>
</tr>
<tr>
<td></td>
<td>Control Group (N = 18)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design Copying</td>
<td>.34*</td>
<td>.43**</td>
<td>.21</td>
<td>.23</td>
</tr>
<tr>
<td>Constructional Praxis</td>
<td>.51**</td>
<td>.30</td>
<td>.13</td>
<td>.00</td>
</tr>
<tr>
<td></td>
<td>Learning-Disabled Group (N = 21)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design Copying</td>
<td>.74***</td>
<td>.72***</td>
<td>.56***</td>
<td>.46**</td>
</tr>
<tr>
<td>Constructional Praxis</td>
<td>.58***</td>
<td>.47**</td>
<td>.16</td>
<td>.40**</td>
</tr>
</tbody>
</table>

Note: SIPT = Sensory Integration and Praxis Tests (Ayres, 1989); VMI = Developmental Test of Visual-Motor Integration (Beery, 1980); Block Design = Block Design subtest of the Wechsler Intelligence Scale for Children-Revised (Wechsler, 1974); Rey-Osterrieth = Rey-Osterrieth Complex Figure Test (Waber & Holmes, 1985). 
1(Haworth, 1970).
* P < .10. ** P < .05. *** P < .01.
The high correlations in the combined sample may be explained in two ways. First, the SIPT constructional measures may be highly related to other measures of constructional abilities. Alternatively, the high correlations may reflect the fact that children with learning disabilities tend to score poorly on most measures, whereas non-learning-disabled children tend to score well on most measures. Thus, the correlations reflect primarily the effect of group rather than of the relation between tests. We therefore performed correlations separately for each group.

As hypothesized, correlations were substantial for the children with learning disabilities. The Design Copying subtest showed a significant correlation with each of the four standardized constructional tests, and the Constructional Praxis subtest showed a significant correlation with three of the four constructional measures. With the control group, however, the Design Copying subtest showed a significant correlation with only one of the four tests, as did the Constructional Praxis subtest. The reason for the difference in correlations between these two groups is unclear. Perhaps the group with learning disabilities showed higher correlations because there is greater variability in scores. Examination of the standard deviations for each group on the SIPT measures (see Table 2), however, indicated that although the standard deviation was greater for the learning-disabled than for the non-learning-disabled subjects on the Constructional Praxis subtest, this was not true for the Design Copying subtest. Moreover, examination of the standard deviations on the other constructional measures did not indicate consistently greater variability for the learning-disabled versus the nondysfunctional group.

Alternatively, there may be a basic level of constructional abilities that is necessary for adequate completion of these tests. Thus, a deficit in constructional abilities would influence all tests. A variety of additional skills, however, could be drawn on to improve performance on individual tests, depending on the test format and components. Children with adequate abilities in visual construction may therefore display variable performance, depending on the strategies used for each test.

Another possibility is that these results reflect basic differences between children with and without learning disabilities in problem-solving strategies. Children with learning disabilities have been noted to be more limited in the strategies that they use (Short, Cuddy, Fricbtert, & Schatschneider, 1990). Possibly, they use one consistent approach for all tasks that involve visual construction, regardless of the format, whereas nondysfunctional children are able to draw on a wider variety of strategies.

We also looked at the pattern of correlations for each group to see if it reflected the nature of the task. For example, the Design Copying subtest involves a drawing task; thus it might be expected to correlate more highly with other drawing tasks, including the Developmental Test of Visual-Motor Integration, the Primary Visual Motor Test, and the Rey-Osterrieth Complex Figure Test. In the control group, however, the Design Copying subtest correlated with the Block Design subtest of the WISC-R. Similarly, the Constructional Praxis subtest correlated only with the Developmental Test of Visual-Motor Integration, not with the Block Design subtest, which assesses assembly (although the Constructional Praxis subtest is three-dimensional, whereas the Block Design subtest is two-dimensional).

Validity was also examined through the use of contrast groups. The hypothesis that the subjects with learning disabilities would score significantly more poorly than the non-learning-disabled subjects on the constructional tests of the SIPT was supported. According to Dunn (1989), "If two groups with known characteristics can be identified and assessed by the new test, and if a significant difference between the performance of the two groups is found, then incisive evidence of test validity will be provided" (p. 163). Dunn further stated that "if evidence can be accumulated which demonstrates that the new test discriminates between normals and the group it was designed to measure, the underlying theory is further substantiated and construct validity enhanced" (p. 164).

In summary, the results of this study lend support to the validity of the Design Copying and Constructional Praxis subtests of the SIPT as measures of constructional abilities in children with learning disabilities. Future research must examine the generalizability of these results to subtypes of learning disabilities. Learning disabilities do not form a homogeneous group. Rather, research suggests that there are subtypes of learning disabilities that exhibit different patterns of strengths and weaknesses (Rourke, 1985). ▲

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<table>
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<th>Table 2</th>
<th>Means and Standard Deviations for the Control and Learning-Disabled Groups on Each of the SIPT Constructional Measures</th>
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<tbody>
<tr>
<td>Constructional Measure</td>
<td>Group ( (n = 16) )</td>
</tr>
<tr>
<td>Design Copying</td>
<td></td>
</tr>
<tr>
<td>( M )</td>
<td>0.48</td>
</tr>
<tr>
<td>( SD )</td>
<td>1.10</td>
</tr>
<tr>
<td>Constructional Praxis</td>
<td></td>
</tr>
<tr>
<td>( M )</td>
<td>0.43</td>
</tr>
<tr>
<td>( SD )</td>
<td>0.45</td>
</tr>
</tbody>
</table>

Note: SIPT = Sensory Integration and Praxis Tests (Ayres, 1989).
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References