Using the Sensory Integration and Praxis Tests to Measure Change: A Pilot Study

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Nineteen boys aged 6 through 8 years were pretested with the preliminary edition of the Sensory Integration and Praxis Tests (SIPT) (Ayres, 1984). They subsequently received 6 months of twice weekly occupational therapy with sensory integration intervention in a school setting and were then posttested with the preliminary edition of the SIPT. Significant improvement was seen in scores of grouped data on tests of praxis, somatovestibular functioning, and bilateral integration and sequencing. Individual improvement was visible in the Western Psychological Services ChromaGraphs of 17 of the 19 boys. Although preliminary, these findings suggest that the SIPT, unlike the Southern California Sensory Integration Tests (SCSIT) (Ayres, 1972a), may be used to document improvement in children who have received occupational therapy with sensory integrative techniques.

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This study was undertaken with the use of the preliminary edition of the Sensory Integration and Praxis Tests (SIPT) (Ayres, 1984), a test battery designed to replace the Southern California Sensory Integration Tests (SCSIT) (Ayres, 1972a). Posttesting with the SCSIT was generally found to be an invalid indicator of improvement in sensory integrative functioning as a result of occupational therapy treatment, and certification course instructors from Sensory Integration International in Torrance, California, advised that the SCSIT be used only as a diagnostic tool. The purpose of this pilot study was to ascertain whether the most recent version of the SIPT (Ayres, 1989) is a sufficiently sensitive instrument to measure change following occupational therapy treatment.

Background

Numerous authors have explored the effectiveness of occupational therapy using sensory integrative techniques. Clark and Pierce (1988) provided a synopsis of those effectiveness studies in pediatric occupational therapy. Defining sensory integrative procedures as "involving engagement in self-directed, purposeful activity rich in the provision of proprioceptive, vestibular and tactile stimulation, requiring an adaptive response, and individually designed" (p. 1), they discussed the effectiveness of sensory integrative procedures in nine group design and four single-subject design studies. Most of the studies that Clark and Pierce reviewed were designed to identify the type of child who would benefit from occupational therapy with sensory integrative procedures. The studies showing the best results were those that used subjects who had learning disabilities and who met strict criteria for sensory integrative occupational therapy. These criteria were normal IQ, preprogram Southern California Postrotary Nystagmus Test (SCPNT) (Ayres, 1975) duration scores of less than −1.1 (interpreted as one sign of vestibular dysfunction), and being aged 8 years or younger (the younger children made the greatest progress in therapy).

Specific conclusions from those efficacy studies were (a) that one type of vestibular processing disorder characterized by depressed postrotatory nystagmus interfered with academic achievement and can be ameliorated by occupational therapy with sensory integrative techniques (Ayres, 1975) and (b) that children with generalized sensory integrative dysfunction and discrete auditory language problems who received occupational therapy with sensory integrative techniques made greater academic gains in reading than did the control subjects (Ayres, 1972b). Clark and Pierce (1988) concluded that throughout the effectiveness studies (a) the results for improve-
and (d) in studies in which children showed positive effects from occupational therapy with sensory integrative techniques; (c) children under the age of 8 years with depressed postrotatory nystagmus are prime candidates for occupational therapy intervention with sensory integrative techniques; and (d) in studies which children showed positive effects from occupational therapy with sensory integrative techniques, the duration of treatment ranged from 25 to 45 min of individualized therapy daily for 5 to 6 months, to a total of 24 hours of individualized sensory integrative procedures over a 6-month period.

The studies reviewed by Clark and Pierce (1988) used the SCSIT and the SCPNT to determine whether children met the criteria for having sensory integrative dysfunction. The SIPT (Ayres, 1989), although maintaining portions of the SCSIT, is not the same test battery and is designed to identify sensory integrative dysfunction, particularly praxis, more discretely than the SCSIT. The SCPNT is now a subtest of the SIPT and is essentially unchanged, except that it must be administered twice.

**Method**

**Subjects**

The present study incorporated the parameters suggested earlier by Ayres (1972b, 1976) and Clark and Pierce (1988) to be the most important in producing change. All of the children had learning disabilities and normal intelligence, as determined by the school, had been mainstreamed into normal classrooms, and were aged 6 through 8 years. All were male and had been identified by an occupational therapist as having potential sensory integrative praxis problems; all had a depressed SCPNT score as a pretest prerequisite for inclusion in the study. All of the children were available to receive two 30-min occupational therapy sessions per week during the school day for 6 months. The age range of the children at the beginning of the study was 73 to 104 months (6 years to 8 years 7 months). The mean age was 7 years 6 months.

The SIPT was given to 21 such children in two New Hampshire elementary schools. In addition to the above parameters, all of the subjects had parental permission to be tested with the preliminary edition of the SIPT and had permission to receive occupational therapy with sensory integrative techniques twice weekly for 6 months before posttesting, again with the preliminary edition of the SIPT. Twenty subjects completed the study, but one pretest was lost during the intervening 6 months, so only 19 cases were actually reported.

**Procedure**

The testing was conducted by three examiners, all of whom had passed a training program in the testing and scoring procedures for the preliminary edition of the SIPT. The pretests and posttests for each child were given by the same examiner. Due to the complexity and the length of the SIPT, I thought that the examiners would not remember how they had scored the subjects 6 months previously and therefore would not inadvertently bias the test results. The prepublication version took 2½ to 3 hr to administer, and at this stage all experimental items were included in the testing. The examiners were unaware of which items would be included in the final test battery. Having the same examiners conduct both pretesting and post-testing eliminated a need to conduct interrater reliability studies. Because the examiners were not involved in the treatment program, they were blind to the children’s progress in therapy. Each child was pretested and posttested in the same room at the same time of day.

Therapy procedures were designed and supervised by an occupational therapist certified in both sensory integration and neurodevelopmental treatment. The direct treatment was provided by two certified occupational therapy assistants who had worked with the therapist for several years.

The children were treated in groups of two for two 30-min sessions each week. These sessions consisted of the following:

1. Proprioceptive input given to the entire body by the therapist, lasting approximately 2 to 5 min, including joint traction and compression with hands, balls, and other objects.
2. A variety of vestibular-proprioceptive activities lasting between 3 and 7 min per session, including the use of a helicopter swing, a hammock swing, a platform swing, a mini trampoline, scooter boards, therapy balls, and a sit-and-spin device. All activities required an adaptive response, such as picking up blocks and throwing them into a bucket while swinging.
3. A variety of tactile activities including sand play; rubbing the body with textured cloth, lotion, and powder; shaving cream games; brushing; and rolling in blankets. All of these activities were sought and regulated by the child.
4. Activities to enhance normal movement patterns during and after vestibular input, including trunk rotation and weight bearing and
weight shift to increase proximal stability in the upper and lower extremities. Such activities included reaching while seated on a beach ball and crab-walk and bear-walk games.

5. Adaptive activities presented during and after the sensory integrative input to enhance the individual educational plans, goals, and objectives. These were mostly practic tasks, including games requiring some socialization, one-to-one correspondence, prehensive tasks, chalkboard activities, peg designs, eye tracking, sequencing and memory activities, and some craft designs and handwriting tasks.

Sensory integration treatment principles were the primary factor in treatment planning, and care was taken to ensure enhancement of normal positions according to neurodevelopmental treatment principles whenever input was given.

Results

The individual SIPT measures were subjected to numerous factor analyses after being given to both non-dysfunctional and dysfunctional samples (Ayres, 1989). As each analysis revealed slightly different groupings of tests, this study used groupings based on logical relationships, that is, grouping together the praxis subtests, the form and space subtests, the somatovestibular subtests, and the bilateral integration and sequencing subtests of the SIPT. Because there were numerous dependent variables in each analysis, a multivariate analysis—the Hotelling's $T^2$ (Huck, Cormier, & Bounds, 1974) for correlated samples—was used to limit positive bias.

The results of the analysis with a separate Hotelling's $T^2$ for correlated samples for each group of tests revealed a positive change in the SIPT scores on three of the four groupings (see Table 1). A post hoc analysis was conducted with a series of paired $t$ tests. To guard against Type I error, the Bonferroni correction (Kirk, 1968) was applied, which resulted in the alpha level being changed from .05 to .003. With the application of this stringent requirement, the Standing and Walking Balance subtest showed a significant positive change from pretesting to posttesting. Three other subtests showed somewhat higher, but still low, probabilities and should be observed in subsequent studies (see Table 2).

Discussion

Although the results of this study are somewhat difficult to interpret, they suggest that positive change occurred in the children studied as measured by changes in at least one SIPT score, Standing and Walking Balance. This finding leads to the tentative conclusion that the SIPT, unlike the SCSIT, may be used to document change in sensory processing.

The purpose of this pilot study, as stated earlier, was to ascertain whether the SIPT can measure change after intervention. A pretest-posttest one-group design was used. Such a design has numerous limitations regarding the relation between the independent and dependent variables. Primarily, no causal association can be implied between the independent variable (i.e., occupational therapy treatment with sensory integration treatment) and the dependent variable (i.e., scores on the SIPT). The ability to document clinical change is not the same as a demonstration that sensory integration treatment increases scores on the SIPT, although it is a first step in that direction.

Changes in pretest and posttest scores can occur for various reasons, the influence of the independent variable being only one of them. Standard error of measurement and reliability as well as such validity

### Table 1
Four Analyses Using Hotelling's $T^2$* for Correlated Samples Comparing Pretreatment and Posttreatment Scores of the Sensory Integration and Praxis Tests

<table>
<thead>
<tr>
<th>Grouping</th>
<th>Subtests</th>
<th>$T$</th>
<th>df</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Praxis</td>
<td>Constructional Praxis, Praxis on Verbal Command, Sequencing Praxis, Oral Praxis, Design Copying, Postural Praxis</td>
<td>5.60</td>
<td>6, 12</td>
<td>.006</td>
</tr>
<tr>
<td>Somatovestibular</td>
<td>Kinesthesia, Finger Identification, Graphesthesia, Localization of Tactile Stimuli, Postrotary Nystagmus, Standing and Walking Balance</td>
<td>11.67</td>
<td>6, 9</td>
<td>.001</td>
</tr>
<tr>
<td>Form and space</td>
<td>Space Visualization, Figure-Ground Perception, Manual Form Perception, Motor Accuracy</td>
<td>5.23</td>
<td>4, 10</td>
<td>.006</td>
</tr>
<tr>
<td>Bilateral integration and sequencing</td>
<td>Bilateral Motor Perception, Oral Praxis, Sequencing Praxis, Graphesthesia, Standing and Walking Balance</td>
<td>10.28</td>
<td>5, 12</td>
<td>.001</td>
</tr>
</tbody>
</table>


### Table 2
Selected Post Hoc Analyses Using Paired $t$ Tests

<table>
<thead>
<tr>
<th>SIPT Subtest</th>
<th>$t$</th>
<th>df</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standing and Walking Balance</td>
<td>-6.20</td>
<td>17</td>
<td>.000</td>
</tr>
<tr>
<td>Localization of Tactile Stimuli</td>
<td>-2.46</td>
<td>18</td>
<td>.024</td>
</tr>
<tr>
<td>Postural Praxis</td>
<td>-2.57</td>
<td>18</td>
<td>.019</td>
</tr>
<tr>
<td>Sequencing Praxis</td>
<td>-2.29</td>
<td>18</td>
<td>.035</td>
</tr>
</tbody>
</table>

Note. SIPT = Sensory Integration and Praxis Tests (Ayres, 1989).
considerations as history, maturation, repeated testing, and statistical regression may contribute to changes in scores.

Because the SIPT was designed to be a diagnostic test, the data were examined to see if changes were reflected in the diagnostic categories to which the children were assigned on the two testings. The results of each child's performance on the SIPT is reported on a Western Psychological Services (WPS) ChromaGraph, which shows the six possible normative groups with which a child may be compared as well as the child's scores. The computer selects the normative group or groups that are most like the child's. The six possible factors, from lowest to highest functioning, are as follows:

1. General Sensory Integrative Dysfunction
2. Visuodyspraxia and Somatodyspraxia
3. Dyspraxia on Verbal Command
4. Low Average Bilateral Integration and Sequencing
5. Low Average Sensory Integration and Praxis
6. High Average Sensory Integration and Praxis

In 17 of 19 cases in this study, the movement in the child's WPS ChromaGraph is visually apparent. Several types of shifts can be identified in the normative data factor or factors with which the children were statistically compared. Eight children's scores shifted upward (improved) in the same or a closely related diagnostic category (e.g., a shift from Low Average Sensory Integration and Praxis to High Average Sensory Integration and Praxis [see Figure 1]). Six children's scores shifted from having several closely related diagnostic categories to one category while also showing improvement (e.g., a shift from Low Average Sensory Integration and Praxis coupled with Low Average Bilateral Integration and Sequencing to High Average Sensory Integration and Praxis [see Figure 2]). Three children's profiles were cleared up diagnostically, moving from a combination of several factors or no factor to one factor (e.g., a shift from no factor to visuodyspraxia or somatodyspraxia [see Figure 3]). Two children's scores did not change; no scores decreased.

The results of three of the analyses with Hotelling's $T^2$ suggested an overall combined difference in the grouped data, but the results of post hoc analyses revealed only one statistically significant difference. A visual examination of the data, however, shows evidence that the children moved from one diagnostic category to another. In the planning of further studies, it may be helpful to consider some of the factors that may have prevented greater differences from being demonstrated statistically. Perhaps the treatment itself was not sufficiently powerful. For example, the subjects were not seen individually, as they were by Ayres (1976), and the subjects were seen only twice a week for 30 min per session, whereas Ayres's (1976) subjects were seen five times a week for 30 min per session. The subjects in the present study were treated for only 6 months; greater changes may have occurred with a longer duration of treatment. The sample size was small and, of course, the use of a control group would have eliminated some of the difficulties involved in interpreting the data. In addition, because the experiment-wise alpha level was maintained at .05, a Type II error cannot be ruled out.

It is interesting to note that the results of the Hotelling's $T^2$ revealed no significant posttest change on grouped data in the form and space grouping, whereas posttest change did occur in the praxis, somatovestibular, and bilateral integration and seq-

![Figure 1](http://ajot.aota.org/pdfaccess.ashx?url=/data/journals/ajot/930321/ on 10/17/2018 Terms of Use: http://AOTA.org/terms)

Figure 1. ChromaGraphs of pretest (left) and posttest (right) results showing upward movement in the same diagnostic category.

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Figure 41 dysfunctional and 10 nondysfunctional children.

...Ground subtest score was also low (.48), unlike previous studies, in which it ranged from .80 for a sample of 63 nondysfunctional children tested 2½ years apart (Kimball, 1981) to .83 for a sample of 42 nondysfunctional children tested 2 weeks apart (Ayres, 1975). All other SIPT test-retest reliabilities are considered to be acceptable, ranging from .69 to .93. Standard errors of measurement are not reported in the SIPT test manual.

Because this project was designed to look only at the SIPT's ability to measure change, no educational measures were included.

Conclusion

This study is the first to attempt to determine if the SIPT can be used to ascertain change. A one-group pretest–posttest design—a preexperimental design—was used because the study's purpose was to examine...
one aspect of the SIPT during an important period of its development. In the present study, boys with learning disabilities were given occupational therapy with sensory integrative techniques. Although a post hoc analysis demonstrated a positive effect in scores of one subtest of the SIPT battery and concomitant changes in the individual WPS ChromaGraphs of most of the children, it is still premature to state that the SIPT, unlike the SCSIT, may be used to measure change following occupational therapy with sensory integrative techniques.

Because of the present study's design limitations, school-based occupational therapy services that provide sensory integration treatment cannot yet be confirmed as being efficacious in increasing practical abilities, somatovestibular processing, and bilateral integration and sequencing skills.

Because educational measures were not a part of this study, a similar study that includes academic areas is needed to reveal if the changes observed in the children's abilities, as measured by the SIPT, translate into academic achievement. Subsequent studies must also include control subjects involved in physical activities that are not a part of occupational therapy, such as free play and gym class.

The SIPT may be more sensitive to changes than the SCSIT due to the more discrete nature of many of its 17 subtests. The elements of developmental dyspraxia have been more clearly identified, which should help to determine the type of practical ability involved in the child's dysfunction. Although it is still unknown whether different types of sensory integrative interventions may be differentially effective for each SIPT profile seen, we have a better understanding of which practical skills may be most influenced by current occupational practices. An analysis of a child's performance on the SIPT determines his or her differential diagnosis and can then help to show whether occupational therapy intervention was effective. The next step must be a confirmation of this pilot study with the use of an experimental design. If such a study demonstrates that the SIPT can be used to measure change following occupational therapy intervention, then the next step would be to develop differential treatment procedures that improve children's functioning with each SIPT profile while also improving academic abilities. In such studies, care must be taken to ensure that the subjects involved are those most appropriate for occupational therapy with sensory integrative techniques.

Although the present study was preliminary, it indicates that the SIPT may be more useful than the SCSIT for the measurement of occupational therapy effectiveness.

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References