Postrotary Nystagmus Response in Children with Down's Syndrome

(sensory integration, vestibular assessment, mental retardation)

Eunice Ling-Fong Zee-Chen  Michael L. Hardman

The purpose of this study was to investigate the nystagmus response in school-age children with Down's syndrome. The 35 subjects were between 5 and 9 years of age and were enrolled in public school programs for the educable and trainable mentally retarded in the northern metropolitan areas of Utah. The Southern California Postrotary Nystagmus Test (SCPNT) was administered with slightly modified verbal instructions. Durations of nystagmus for the subjects with Down's syndrome were compared with Ayres' normative data from the SCPNT using a t-test for two independent means. Results indicated there was a significant reduction in the duration of nystagmus in the children with Down's syndrome when compared to Ayres' sample of normal children; however, there was no significant difference between males and females with Down's syndrome in duration of postrotary nystagmus.
The importance of the relationship between the functions of the vestibular system and human development has received some attention from investigators in recent years (1-4). A number of studies have demonstrated that the vestibular system contributes to the development of muscle tone and motor skills, language acquisition, and academic learning (5-19). Nystagmus (an eye reflex) is one indicator of vestibular function because of its association with the vestibular mechanism. Nystagmus can be assessed by electronystagmograph, the calor-ic, and rotary tests. Several investigations (7, 16, 20) have focused on the postrotary nystagmus responses of delayed or disabled children. Ayres Jr. Foundation Public Policy

Fellow.

Michael L. Hardman, Ph.D., is Associate Professor, and Director of Graduate Studies, Department of Special Education, University of Utah, and Joseph P. Kennedy, Jr. Foundation Public Policy Fellow.

Eunice Ling-Fong Zee-Chen, M.S., OTR, is an occupational therapist, Jordan School District, Utah, and certified in the administration of the Southern California Sensory Integration Tests.

Rendle-Short (16) compared the postrotary nystagmus responses of normal children and those with minor neurological impairment. They found that mean duration of postrotary nystagmus was higher in the normal population (x = 15.6 seconds) than in the children with neurological impairment (x = 5.7 seconds). Ritvo, Ornitz, Eviatar, Markham, Brown, and Manson (20) found a significant decrease in the postrotary nystagmus responses of autistic children in a lighted room. They suggested that there may be developmental lags in the vestibular organs or a difference in the arousal mechanism of this population.

One population that has received little attention in the research associated with vestibular function is children with Down's syndrome. This population exhibits hypotonicity, as well as delays in gross motor skills, language development, and academic learning (21-26). These characteristics suggest the possibility of vestibular dysfunction. In reviewing the literature, the authors were able to locate only one study focusing on Down's syndrome and nystagmus responses. Kantner, Clark, Allen, and Chase (12) studied motor improvement and postrotary nystagmus responses in infants with Down's syndrome. The experimental group, which comprised two normal infants and two infants with Down's syndrome, were provided with ten treatments of specific vestibular stimulation. The control group, comprising one normal infant and two infants with Down's syndrome, did not receive treatment. Results indicated that subjects in the experimental group exhibited more improvement on reflex testing when compared with the control sample. Before the vestibular stimulation treatment, the children with Down's syndrome exhibited prolonged postrotary nystagmus. Kantner, et al. postulated that the prolonged nystagmus indicated vestibular hyperactivity resulting from failure in maturation of an inhibitory circuit in the central nervous system. After treatments of vestibular stimulation, the postrotary nystagmus declined in both normal children and children with Down's syndrome. It should be noted, however, that the sample in this study was small and the subjects were 6 to 24 months of age. Consequently, these results cannot be generalized to school-age children with Down's syndrome.

The purpose of the present investigation was to assess postrotary nystagmus in school-age children with Down's syndrome and determine if any significant difference existed between their performance and the performance of the sample of normal children on which the Southern California Postrotary Nystagmus Test (SCPNT) was standardized (27). Whether or not there were six differences in nystagmus responses of the sample with Down's syndrome was also investigated. The following hypotheses were formulated: 1. that there would be a significant difference in the duration of postrotary nystagmus (as measured by the SCPNT) between children with Down's syndrome and Ayres' sample of normal children; 2. that there would be no significant difference between the duration of postrotary nystagmus of boys and girls within the population with Down's syndrome.

The limitations of this study relate primarily to the use of the SCPNT as a measure of vestibular functioning. The SCPNT has been criticized as being less reliable than the caloric testing or electronystagmograph (ENG) in assessing prob-
Table 1
Number (No.) of Subjects (S), Means (X), and Standard Deviations (SD) Are Recorded in Seconds of Nystagmus Duration following Rotation to S's Left (L), and Right (R), and Total of Left and Right Scores by Age and by Sex

<table>
<thead>
<tr>
<th>Age (Yr)</th>
<th>5.0 - 5.11</th>
<th>6.0 - 6.11</th>
<th>7.0 - 7.11</th>
<th>8.0 - 8.11</th>
<th>9.0 - 9.11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>M</td>
<td>F</td>
<td>M</td>
<td>F</td>
<td>M</td>
</tr>
<tr>
<td>No. of S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>5</td>
<td>4</td>
</tr>
</tbody>
</table>
before testing. Such extravestibular stimulation was minimized so that a more accurate picture of the subjects' nystagmus responses would be obtained. The test was given by an occupational therapist certified in its administration in a lighted, quiet room within the children's school.

The procedures for the administration of the SCPNT were as follows. The child was asked to sit on the standardized postrotary nystagmus board in a cross-legged fashion. Verbal or physical assistance was provided if needed. The child was then given the standardized instructions with the exception of the previously mentioned modifications. His head was placed in a 30-degree forward position (measured with an angle guide) so that the semicircular canals were positioned in the horizontal plane. The child was rotated 10 times in 20 seconds, first to the left, then to the right. An interval of at least 60 seconds was provided to allow the child time to express reactions toward the stimulation. At this time the examiner also recorded observations regarding the child's head and trunk balance.

The test was considered invalid if the child reacted in any way that prevented the examiner from observing the actual postrotary nystagmus. The examiner looked for such factors as failure to keep eyes open or focusing on a specific object instead of looking at a blank wall. A position change of more than 15 degrees for the head was also considered invalid. When the child's head was flexed 30 degrees from vertical, the horizontal semicircular canals were approximately positioned in the plane that would produce horizontal nystagmus when stimulated. Test-retest reliability was performed by the same therapist at least 1 week after the initial test and without the results of the last test on hand.

Results

Durations (seconds) of postrotary nystagmus were compiled for each direction rotated and for the total of both directions. Mean and standard deviations were obtained for each age category by age and sex. Table 1 summarizes the average number of seconds of nystagmus and standard deviations following rotation to the left, the right, and the total of these scores by age and sex. Data are also given for both sexes combined.

Mean scores for the total sample with Down's syndrome were computed and are reported in Table 2 together with the normative data from the SCPNT. An independent t-test (30) was used to compare the differences between the total combined scores of the Down's syndrome and the normative data. A significant difference (t = 3.25, p < .01) was noted. The difference between total mean scores of males and females with Down's syndrome was not statistically significant at the .05 level using a two-tail t-test for independent means.

Reliability of measurement was obtained by computing a t-test for correlated samples between two tests given at least 1 week apart to 15 subjects. No significant difference was found (t = .143, p > .05). Data analysis with the Pearson product-moment correlation indicated acceptable test-retest reliability (r = .88).

Clinical observations of the responses of the subjects to the SCPNT were recorded and analyzed. Twenty-nine subjects had a pleasurable reaction. Six subjects expressed neutral reactions, but did not refuse the test. Only 3 of the 35 subjects exhibited an alarm reaction to the testing. During rotation 20 subjects were able to maintain total body balance and the other 15 demonstrated a slight loss of balance. However, upon abrupt stop, 3 subjects were able to maintain steady balance, 26 subjects exhibited slight loss of balance, 3 lost balance but regained it, and the other 3 lost balance and fell into the examiner's

<table>
<thead>
<tr>
<th>Sample</th>
<th>Down's Syndrome</th>
<th>Normal*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>F</td>
</tr>
<tr>
<td>No. of S</td>
<td>17.0</td>
<td>18.0</td>
</tr>
<tr>
<td>X of L</td>
<td>6.9</td>
<td>7.8</td>
</tr>
<tr>
<td>SD to L</td>
<td>3.3</td>
<td>2.7</td>
</tr>
<tr>
<td>X to R</td>
<td>8.2</td>
<td>7.1</td>
</tr>
<tr>
<td>SD to R</td>
<td>4.4</td>
<td>2.4</td>
</tr>
<tr>
<td>X of total</td>
<td>15.1</td>
<td>15.0</td>
</tr>
<tr>
<td>SD of total</td>
<td>7.4</td>
<td>5.0</td>
</tr>
</tbody>
</table>

† Values used for the t-test to calculate the significance between the two samples.

* Reprinted by permission. Copyright © 1975 by Western Psychological Services.
It is interesting to note that no subjects in Ayres’ original sample (N = 226) exhibited an absence of nystagmus. However, an absence of nystagmus was noted for one child with Down’s syndrome in the present investigation (N = 35). Table 3 illustrates the distribution of total (left and right combined) nystagmus durations following rotation for children with Down’s syndrome in the present investigation as well as learning-disabled and normal samples as reported by Ayres (27). The total mean duration for the population with Down’s syndrome was less than that for the normal sample. The mean duration for male subjects with Down’s syndrome was 15.1 seconds as compared to 15.0 for females. For both sex groups this yields a “low-average” range (−.7 and −.5 standard deviations, respectively) when compared to Ayres’ standard deviation score equivalents on the normal sample.

**Discussion**

The analysis of data revealed that there was no significant difference in the duration of postrotary nystagmus between male and female subjects with Down’s syndrome. However, the results did suggest a significant difference in duration of postrotary nystagmus between the children with Down’s syndrome and the sample of normal children on whom the SCPNT was standardized. Subjects with Down’s syndrome fell into the “low-average” range when compared to Ayres’ normal sample. These results are not consistent with those of Kantner, et al. (12), who found a prolonged postrotary nystagmus in infants with Down’s syndrome when compared to normal infants. The inconsistency between results of the two studies may be due to procedural (darkened vs. lighted room), or age (infant vs. school age) variance.

A study by Ayres (27) of 226 normal children suggested that nystagmus is atypical if it is found to be either excessively increased or reduced. The present investigation found that subjects with Down’s syndrome had a greater percentage of reduced nystagmus below the normative range than Ayres’ sample of normal children (20% compared to 10%). The reason for this difference requires further investigation. The Ayres’ sample was drawn from California and the subjects in this study were in Utah schools. Subsequent research should include subjects that are age, sex, socioculturally, and geographically matched.

The compilation of clinical observations during testing provides additional information for interpretation of the nature of sensory integration in children. Ayres (27) reported that an average child did not lose balance following 40 seconds of rotation nor did the child exhibit loss of head balance.

Subjects with Down’s syndrome in this study exhibited balance loss more frequently—15 (43%) demonstrated some loss of balance during...
rotation, and (91%) lost balance upon stopping abruptly. However, the majority of subjects were able to maintain head control during rotation with some fluctuation from the original head position. If the child’s head had fluctuated up or down, this could have produced vertical or circular postrotary nystagmus (27, 31). Twenty-nine subjects (83%) expressed pleasure following rotation. Some continued to play with the nystagmus board after the test; others expressed a desire for more rotation. A few did not want to leave the rotating board.

Additional investigation of children with Down’s syndrome should focus on other sensory systems (e.g., tactile, proprioceptive), thus enabling educators and clinicians to more effectively plan remedial strategies. Finally, there is a need to investigate the long-term impact of early sensorimotor intervention on the nystagmus responses and other parameters of function of children with Down’s syndrome.

The results of this investigation must be interpreted with caution. Evidence of reduced nystagmus alone does not imply generalized vestibular dysfunction in children with Down’s syndrome. In addition, the relationship between vestibular dysfunction and developmental delay has not been clearly established. Further research is needed in the above areas before definite conclusions can be drawn regarding the appropriateness of a sensory integrative approach with children with Down’s syndrome. However, if further research establishes a relationship between low postrotary nystagmus and vestibular dysfunction, then vestibular stimulation, as advocated by some therapists (32-34), may prove to be a valuable treatment for this population.

Acknowledgment
The authors extend their appreciation to A. Jean Ayres, Ph.D., OTR, for her contribution, advice, and encouragement.

REFERENCES
2. Ayres AJ: Sensory Integration and Learning Disorders, Los Angeles: Western Psychological Services, 1972
27. Ayres AJ: Southern California Postrotary Nystagmus Test, Los Angeles: Western Psychological Services, 1975