A comparison study was conducted in which 372 subjects, ages 3 through 10 years, were tested by using the Southern California Postrotary Nystagmus Test. The purpose of the study was to determine the generalizability of the original normative data for the test by using a larger sample and an expanded age range of subjects. A comparison of these data from the comparison study with the original normative data showed close agreement. No significant differences in vestibular responsivity were obtained for age, sex, or interaction. Test-retest reliability was comparable to that found for the original normative group. The results of the comparison study were consistent with the original normative data and suggest that they may be applied to subjects from 3 through 10 years of age.
rotary stimulation is in manually maintaining the constant velocity required and in producing the same degree of impulsive deceleration each time the test is given. Even when rotation is precisely controlled, however, there is variability of response among subjects. It has been suggested that such factors as stress, fatigue, level of mental alertness, lighting conditions, and habitation all contribute to the variability of response in normal subjects (3).

Keating compared results obtained using the SCPNT with the results using electronystagmography in 20 normal adult females and in small samples of normal girls and learning-disabled girls. Her findings suggest that the SCPNT may yield comparable findings to electronystagmography, particularly for the duration measurement (4).

Since the SCPNT normative group consisted of 226 children from two public schools in the Los Angeles county area, the test has been criticized on the basis of limited sample size and a local population. Examiners using the SCPNT could feel more secure in generalizing from the normative data if larger samples were tested and comparable results obtained. Some recent investigations have contributed additional normative data that are useful in providing more information about vestibular responses in normal individuals.

Kimball reported normative data on the SCPNT collected in Syracuse, New York (5). She tested a sample of 222 normal children from 5 through 9 years of age and compared the results with Ayres' original normative data. Kimball found significantly higher means and standard deviations than those seen in Ayres' data and proposed a combined standard score table with a higher cutoff point for identifying prolonged nystagmus. Kimball's analysis of variance revealed no significant differences in scores by age, sex, or interaction. Kimball also retested 63 children 2½ years after initial testing with the SCPNT and obtained a test-retest reliability coefficient of .80 for total duration scores. Although she noted that the SCPNT appeared to be stable with normal subjects, Kimball warned that SCPNT results should be interpreted cautiously when used with dysfunctioning children. Because of the differences seen, Kimball suggested that regional norms be developed and that larger samples be used.

Royeen also investigated the test-retest reliability of the SCPNT. Although her sample consisted of only 24 subjects, Royeen found a reliability coefficient of .85 for total duration measurements in her group. Reliability coefficients were not affected by time of retest or subjects' sex in her study (6).

The lack of normative data for pre-school children has been a limiting factor in the usefulness of the SCPNT. Since early identification of sensory-integrative dysfunctions is considered of major importance, it would be desirable to obtain normative data for this age group. An attempt was made to provide information on vestibular responses in pre-school children in three recent studies. Kaufman studied postrotary nystagmus responses in 3- to 5-year-old children in 1978 (7). Her results showed an interaction effect between age and sex for the 3-year-old group only. She also found significantly greater variability in average nystagmus duration in her 5-year-old group than that seen for both boys and girls in Ayres' 1976 data. Kaufman reported a test-retest reliability coefficient of .98 for duration measurements, but this was based on a sample of only five subjects. Kaufman speculated that variables in lighting conditions, visual fixation, and mental alertness may have accounted for the greater variability of responses in the 5 year olds. Inconsistent head positioning and differences in the degree of acceleration may have also played a role. She concluded that separate norms, divided according to sex, were needed for the 3-year-old group but that combined normative data were appropriate after that age. She recommended improving the control of some test variables in order to achieve greater accuracy of SCPNT scores, and also suggested testing larger numbers of 3- to 5-year olds in order to provide additional data for this age group.

Little data are available on the vestibular responses of normal subjects at higher age levels. Shuer, Clark, and Azen found significant differences between the mean duration measures for adult males and 5- to 9-year-old boys. The 5- to 9-year-old boys showed lower mean durations, suggesting that the duration of nystagmus may increase as a function of age. They note that nystagmus has been shown to become more prolonged up to the age of 60 years and then declines (8).

Recent research in sensory integration appears to implicate the vestibular system as a major contributor to learning and to overall development. Because of the probable importance of the vestibular system, the results of the SCPNT are weighted heavily when interpreting the test results of children suspected of sensory-integrative dysfunction. Since the SCPNT plays a major role in the identification of such children, it was believed that additional normative data should be collected.
Table 1
Means and Standard Deviations of Duration Measurements by Group

<table>
<thead>
<tr>
<th>Age Levels by Years</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>M</td>
<td>F</td>
<td>M</td>
<td>F</td>
<td>M</td>
<td>F</td>
<td>M</td>
<td>F</td>
</tr>
<tr>
<td>N</td>
<td>15</td>
<td>7</td>
<td>12</td>
<td>10</td>
<td>24</td>
<td>20</td>
<td>27</td>
<td>28</td>
</tr>
<tr>
<td>Standard Deviation to the Left</td>
<td>2.32</td>
<td>2.43</td>
<td>1.67</td>
<td>1.15</td>
<td>3.23</td>
<td>2.16</td>
<td>2.65</td>
<td>2.99</td>
</tr>
<tr>
<td>Standard Deviation to the Right</td>
<td>2.26</td>
<td>1.77</td>
<td>1.80</td>
<td>1.44</td>
<td>3.06</td>
<td>2.70</td>
<td>2.73</td>
<td>2.55</td>
</tr>
<tr>
<td>Standard Deviation, Total Duration</td>
<td>4.16</td>
<td>4.01</td>
<td>2.72</td>
<td>1.85</td>
<td>5.83</td>
<td>4.54</td>
<td>5.01</td>
<td>5.12</td>
</tr>
</tbody>
</table>

*Significantly different from Ayres' data
and expanded to include a wider age range of subjects. The study reported here was an attempt to investigate the generalizability of Ayres’ normative data and to explore the applicability of the SCPNT to an extended age range.

A comparison study was designed in which the SCPNT would be administered to a larger sample of subjects from ages 3 through 10 years of age. The resulting data would be compared to Ayres’ normative data for 5- through 9-year-old children. The following hypotheses were proposed:

1. The mean durations of nystagmus for right, left, and total scores will show significant differences from those seen in Ayres’ normative data.

2. There will be statistically significant sex differences seen in response to rotatory stimulation of the vestibular system.

3. There will be statistically significant age differences seen in vestibular responsivity among the younger groups of subjects.

4. Test-retest reliability will be found at a level of .75 or greater, comparable to that shown in Ayres’ normative data.

Method
Normal children from 3 through 10 years of age were to be sought for the comparison study. Procedures were developed for locating subjects and obtaining informed consent and were approved by the University’s Committee for the Protection of Human Subjects. Eleven schools and pre-schools agreed to participate in the study. Parents of all children in the 3- through 10-year-old age range were contacted and parental consent was obtained for 372 children. The parents of 56 subjects agreed to have their children tested twice to obtain a test-retest reliability coefficient. All subjects were enrolled in regular school or pre-school programs. The sample included 182 males and 190 females.

The Southern California Postrotary Nystagmus Test was administered in the standard manner by a project assistant who had been trained in the procedure by a CSSID faculty member. Two minor variations in the standardized test procedure were permitted. Very small children were permitted to hold the board with their hands at their sides rather than in front of them in order to better maintain the head in 30° of flexion. The verbal directions to subjects were varied slightly from “sit like an Indian with your legs crossed” to “sit like I am sitting.”

Three hundred sixteen subjects were tested once, and 56 subjects were tested twice, with a 2-week interval between tests. Testing was conducted at varying times of day in space located in the school or preschool the subject attended.

Results and Discussion
Table 1 summarizes the data that resulted from the comparison study. Mean duration of nystagmus to the left and right, and the total of these two scores are shown by age and sex. Standard deviations are shown for each group. The data from the comparison study were analyzed by means of a standard ANOVA program. A 2 x 8 analysis of variance showed no significant differences for age, sex, or interaction (Table 2). Test-retest reliability coefficients
were calculated using Pearson correlation coefficients. Test-retest reliability was calculated in three categories: duration of nystagmus to the left \((r = .73)\), duration of nystagmus to the right \((r = .79)\), and total nystagmus duration \((r = .82)\). A test-retest reliability coefficient of .62 was obtained for the total excursion measurement.

Thirty \(t\)-tests were performed comparing nystagmus durations for right, left, and total scores by age and sex with those reported by Ayres for subjects 5 to 9 years of age. With the exception of the group of 5-year-old boys, there were no statistically significant differences between the Ayres' data and the comparison study data. In the comparison sample, 5-year-old boys exhibited a longer mean duration following rotation to the left and right than in Ayres' data. Since this finding occurred in a single group of subjects, it may be due to sampling error or uncontrolled environmental variables.

Since the comparison study data closely approximated Ayres' normative data, Hypothesis 1 could not be supported. Nystagmus durations seen in the comparison sample did not show significant differences in means from those in Ayres' sample. No significant sex differences emerged in the comparison data; therefore, Hypothesis 2 was not supported. It should be noted that Ayres found significant sex differences using a one-tail test. In the comparison study, a two-tail test was used since that was considered more appropriate. Hypothesis 3 also was not supported: No significant age differences in vestibular responsiveness were seen in the comparison study, even among the younger subjects. Because the age range was expanded in this study, the investigator anticipated seeing some differences, particularly in the 3-year-old groups. This was not the case. Since vestibular responses did not appear to be age related in this sample, it is believed that the standard scores reported by Ayres may be applied to children from ages 3 through 10.

Hypothesis 4 was supported by the comparison study findings. A test-retest reliability coefficient of .82 was obtained for total duration scores. This compares with a test-retest coefficient of .83 reported by Ayres, .80 reported by Kimball, and .83-85 by Royeen. The consistency of these data would suggest that the SCPNT is reliable over time as a measurement instrument. Duration measures were found to be considerably more reliable than excursion measures.

Implications for Occupational Therapy

Generally, the trends seen in the comparison study data were consistent with those reported by Ayres. The sex differences in responsibility for 3 year olds reported by Kaufman were not seen in this study. The higher means and variances reported by Kimball were not seen in this normative group. It is interesting that the study data showed greater variability of responses for 5-year-old boys, a finding somewhat comparable to that of Kaufman. It is likely, however, that this was due to uncontrolled variables or sampling error.

The comparison study provided new normative data for children from 3 through 5 years and for 10 year olds. The additional data for these age ranges provide support for the use of the SCPNT with preschool children, and it is hoped that it will be a useful tool in the early identification of children with sensory-integrative disorders. The results of this study are comparable to Ayres' 1976 normative data, and it is believed that examiners may generalize from these data with confidence. As more information is gained about vestibular responsibility, occupational therapists may be able to more effectively apply appropriate evaluation and treatment techniques with dysfunctional individuals.

Acknowledgment

The investigator acknowledges the active assistance and support of school administrators and teachers who participated in the project. Special appreciation is due to Kathy Rust, OTR, who served as project assistant for the study. This investigation was funded by a grant from the Graduate School, University of Wisconsin—Madison.

REFERENCES

1. Barany R: Physiologie and Pathologie des Bogengangsapparates beim Menschen, Deuticke, Vienna, 1907