Duration and Quality of the Prone Extension Position in Four-, Six-, and Eight-Year-Old Normal Children

(vestibular-based functions, sensory integration)

Nancy P. Harris

This study was designed to determine whether developmental changes occur in the duration and quality of maintaining a prone extension position. Three groups of 26 to 30 normal children ages 4, 6, and 8 years were tested on the prone extension position. Results indicated a significant difference in both duration of maintenance and quality between the performance of the four-year-olds and the other two age groups. No significant differences were found between the six- and eight-year-olds. Smooth assumption of the position and distance of thighs off the mat were found to be the most important factors in discriminating a good prone extension position from an inadequate one. The variability of performance by the four-year-olds indicates that the ability to assume and maintain a prone extension position is not a valid measurement tool for discriminating between normal children and those "at risk" for learning disabilities at this age level. The inability of children six years or older to maintain a "good" prone extension position for 30 seconds suggests a vestibular processing inefficiency.

Some children with learning disabilities have been found to have deficits in the processing of vestibular stimuli (1-5). A number of different methods have been used to measure vestibular system efficiency in the child with learning disabilities. The measurement of standing balance with eyes closed is one common method (6). Assessment of the duration and amplitude of postrotary nystagmus is another method (7,8). The prone extension position is also used for differential diagnosis of children suspected of having sensory integrative dysfunction (1, 9). Otenbacher (9) found a significant correlation between the prone extension position and postrotary nystagmus.

The prone extension position requires the simultaneous raising of the head, chest, arms, and legs from the floor while lying on one's stomach. This arched back position requires maximum extension of the neck, trunk, and hips, and retraction of the shoulders. According to Ayres (10), the inability to assume and maintain the prone extension position was thought to reflect inadequate integration of the tonic labyrinthine reflex. More recently, she stated that the inability of children with minimal brain dysfunction to assume this position probably should be interpreted as insufficient vestibular processing rather than as a poorly inhibited tonic labyrinthine reflex (1). Since the prone extension position is frequently assessed, together with other righting and equilibrium reactions, by therapists who evaluate children suspected of having learning disabilities, an objective measurement of performance is necessary.

Ayres suggests that normal children age six and older usually can lift both ends of the body simultaneously in a smooth coordinated manner and maintain the position for 20 to 30 seconds, with moderate exertion, whereas less skill may be
expected of younger children. This statement, however, has been based primarily on clinical observations, since developmental norms do not exist. Qualitative observations are subjective, and depend to a large degree on the therapist's experience. Therefore, the development of a qualitative scale was believed necessary.

The purpose of the present study was to determine what developmental changes of both duration and quality may occur in a normal child's ability to maintain a prone extension position.

**Method**

**Subjects.** Of 84 children participating in this study, 26 were 4-year-olds (mean age 4 years 6 months); 28 were 6-year-olds (mean age 6 years 5 months); and 30 were 8-year-olds (mean age 8 years 5 months). Each group comprised about half boys and half girls (4-year-olds: 14 girls, 12 boys; 6-year-olds: 14 girls, 14 boys; 8-year-olds: 13 girls, 17 boys).

The four-year-old children were enrolled in one of two private nursery schools, and the others were enrolled in a public elementary school. All schools were located in the same average to above-average socioeconomic suburban community in Rhode Island.

All subjects were considered normal. Classroom teachers eliminated from the study all children who were not in appropriate grade for age; not considered average or above in intellectual potential; not achieving at the appropriate grade level in reading, math, and spelling; or in the case of the preschool children, not considered at a level developmentally appropriate for age in perceptual, fine motor, and language skills; or not expected to be promoted to the next grade level in June. In addition, children who were receiving medication for seizures, or receiving, or through to need, remedial or resource help were eliminated from the study, as well as hyperactive or otherwise neurologically involved children, and those who were suspected of or diagnosed as being learning disabled.

**Procedure.** Two children from the same age group were tested together in a small room separate from the classroom. One examiner administered all testing. Children were told to sit down and remove their shoes. The examiner then explained that they were going to pretend to fly like an airplane, and to see how long they could do so. The examiner lay down on the mat and demonstrated the prone extension position, while verbally explaining what to do (i.e., raise head, chest, arms, and legs off the floor simultaneously, with legs straight and elbows bent). Each child was helped to assume the position and held for less than 5 seconds to minimize the possibility of tiring. Each child was told that a stop watch would be used to measure the time he or she could hold the position, but to count aloud along with the examiner (to avoid holding the breath). When it was determined that the child understood what to do and was ready, the first trial was begun. Each child received a second trial after the other child had a turn. The best trial was selected for data analysis. Duration of maintaining the position was measured with a stop watch to the nearest second. Timing began when the child raised his or her head from the mat until arms, head, or legs returned to the mat, or until 30 seconds was reached. Thus, each child received a duration score of from 0 to 30 seconds.

Behavioral observations regarding the quality of assuming and maintaining the prone extension position were made using the qualitative rating scale devised for this project (Table 1). To identify the various qualitative components of the prone extension position, 10 therapists were asked to view 13 normal children who were assuming and maintaining the prone extension position. The therapists listed any qualitative observations they noted. The most frequent and most differentially descriptive terms were compiled into a rating scale, and subsequently tested for its usability by 10 different occupational and physical therapy graduate students, who viewed 10 children on a videotape. The present 6-item scale is the result of these efforts. Each item is scored 0, 1, or 2; thus, the range of scores is 0 to 12. Prior to testing, inter-rater reliability was computed on the scores for six children who were videotaped for this purpose, ($r = .89$). In addition, inter-rater reliability was also computed using the same videotape, ($r = .81$).

**Results**

A significant difference in duration occurred between the three age groups, $f = 17.427, p < .001$. The Scheffe Procedure was used to determine the source of the difference. The difference found was between the four- and six-year-old groups ($p < .05$) and the four- and eight-year-old groups ($p < .05$). No significant difference in duration scores was found between the six- and eight-year-old groups. Table 2 presents the range, mean, and standard deviation of duration scores for the three groups. No significant differences were found between boys and girls within any age group.

The mean duration scores of the six-year-old group was lower than
in the quality of performing the prone extension position. The range and median quality scores for each group also appear in Table 2. No significant differences were found between quality scores of boys and girls within any age group. The Kruskal-Wallis test for ordinal data was performed, and a significant difference was found, $H$ (corrected for ties) = 29.154, $p < .001$. The Mann-Whitney U test was used to determine the source of this difference. Again, the difference was found to exist between the four- and six-year-olds, $z = -4.076, p < .001$, and the four- and eight-year-olds, $z = -4.860, p < .001$. No significant different was found between the six- and eight-year-old groups.

Figure 1 presents the variability in quality scores for the different age groups. Whereas 77 percent of the four-year-olds received scores of 7, 8, or 9, only 19 percent received a score of 10 or better. Scores of 10, 11, or 12 were used to designate a "good" position. Seventy-one percent of the six-year-olds and 80 percent of the eight-year-olds received a "good" score. This indicates that the qualitative rating scale was helpful in measuring qualitative changes associated with age, at least those of the eight-year-old group. This was caused by one child (age 6.0) who was unable to assume the position and thus received a score of 0 seconds; all other children maintained the position for the full 30 seconds. Duration scores of the four-year-old group were extremely variable. Thirty-one percent were unable to assume the position; 50 percent were able to maintain it for 26 to 30 seconds; one or two children maintained the position for each of the other 4-second intervals.

There also was a significant difference between the three age groups in the quality of performing the prone extension position. The range and median quality scores for each group also appear in Table 2. No significant differences were found between quality scores of boys and girls within any age group. The Kruskal-Wallis test for ordinal data was performed, and a significant difference was found, $H$ (corrected for ties) = 29.154, $p < .001$. The Mann-Whitney U test was used to determine the source of this difference. Again, the difference was found to exist between the four- and six-year-olds, $z = -4.076, p < .001$, and the four- and eight-year-olds, $z = -4.860, p < .001$. No significant different was found between the six- and eight-year-old groups.

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<th>Score position observed the majority of time held.</th>
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**Table 1**

<table>
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<tr>
<th>Qualitative Rating Scale</th>
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<td>Score position observed the majority of time held.</td>
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**Assumes**

1-segmentally

2-smoothly and quickly, all body parts rise simultaneously

**Head**

1-face raised less than 45°, or position of head varies, or both

2-face vertical (> 45°) and held steady

**Upper Trunk**

1-back appears flat or minimally arched, elbows forward of shoulders, or both

2-definite arch and elbows even with or in back of shoulders

**Thighs**

1-barely off, a sheet of paper can be slid under knee, but not much above knees

2-clearly off mat, from mid thigh distally

**Knees**

1-definitely flexed (50° or more)

2-slightly bent (45° or less)

**Maintains**

1-considerable effort or minimal (due to knees remaining on mat)

2-moderate exertion expended

0 score possible if head, hands, or knees remain on mat.

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<tr>
<th>Duration (seconds)</th>
<th>Quality</th>
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<tr>
<th>Age</th>
<th>Range</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Range</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>Four-Year-Olds</td>
<td>0-30</td>
<td>18.15</td>
<td>13.45</td>
<td>3-12</td>
<td>8.36</td>
</tr>
<tr>
<td>Six-Year-Olds</td>
<td>0-30</td>
<td>28.93</td>
<td>5.67</td>
<td>7-12</td>
<td>11.00</td>
</tr>
<tr>
<td>Eight-Year-Olds</td>
<td>(All subjects scored 30)</td>
<td>30</td>
<td>0.0</td>
<td>8-12</td>
<td>11.00</td>
</tr>
</tbody>
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in comparing the performance of four-year-olds with the performance of the older children.

To determine whether specific developmental changes in quality could be found for each age group, discriminant analysis was performed to see how well group membership could be predicted by weighting the six qualitative variables. Sixty percent of the sample was classified correctly, with 61.5 percent of the four-year-old group, 75 percent of the six-year-old group and 43.3 percent of the eight-year-old group assigned to the correct group. The reason more six-year-olds than either of the other two groups were predicted correctly is not certain.

There were two discriminant functions identified, with the first accounting for almost 92 percent of the variance. In the first function, the two most important variables were smooth assumption and thighs definitely off the mat. The second function was not very clear, but it accounted for only about 8 percent of the variance, and thus should not be considered very significant.

Spearman Correlation Coefficients were computed in an attempt to determine whether duration and quality correlated significantly enough to predict one variable from the other. A significant correlation existed between duration and quality (r = 0.76, p < .001) for the four-year-old group. The lack of variation in duration scores of the six- and eight-year-olds, however, made a correlation between quality and duration scores inappropriate for these two groups.

Discussion

The major purpose of this study was to obtain some data on the ability of normal children to assume and maintain a prone extension position, and to examine them for developmental changes. If the prone extension position is to be used as one measure of assessing the efficiency of vestibular system processing in differentiating between normal children and those suspected of having learning disabilities, and developmental changes do occur, then one must know what to expect at different age levels.

Results of this study concur with Ayres' (10) original tenet that children ages six and older can generally maintain the prone extension position for 20 to 30 seconds with moderate exertion, whereas less skill may be expected of younger children. The variability in performance exhibited by the four-year-olds indicates that the ability to assume and maintain a prone extension position is not a valid measurement.
tool to use for discriminating between normal children and those “at risk” for learning disabilities at this age level. The fact that such a high percentage of the normal children six years and older were able to maintain a “good” (quality score of 10, 11, or 12) prone extension position for 30 seconds suggests that a child of at least six who is unable to do so should be further evaluated for vestibular processing inefficiencies, other learning difficulties, or both.

Results of this study may have been skewed high, however, because of the conscious effort made to exclude children with suspected learning problems, the use of the best of two scores, and also the homogeneity of the sample, which did not include a broad socioeconomic population. However, as the purpose of this study was to evaluate a test item that could help differentiate “at risk” children, it was thought that those suspected of having learning problems should be excluded. Recording of the best score was chosen to allow for variability in children’s capacity to quickly understand a new task and exactly what was expected of them. One generally would use the same approach in testing a child suspected of learning disabilities.

Further analysis of the components of qualitative changes is needed to determine exactly what the expectations are for children at various ages, what the factors are which differentiate between normal and learning-disabled children; and to determine whether learning-disabled children demonstrate a delayed pattern or a different pattern compared with normal children their age. Comparison of “normal” four-year-olds with a group of four-year-olds who are “at risk” for learning disabilities, to see if the kind of difficulties are the same or different, would be valuable. It also would be useful to extend this study to measure the quality of five-year-old children’s performance, as well as, to include a broader socioeconomic population.

Summary
Three groups of normal children ages four, six, and eight years were tested on the prone extension position. A significant difference in duration and quality of maintaining the prone extension position was found between the four-year-old group and the six- and eight-year-old groups. No significant difference was found between the two older groups. Various aspects of quality of performance were identified as particularly relevant. Smooth assumption of the position and distance of thighs off the mat were found to be the most important factors in discriminating a good prone extension position (quality score of 10 to 12) from an inadequate one. The variability of performance by the four-year-olds suggests that this measure is neither a reliable nor a valid one for discriminating between normal and “at risk” four-year-olds. Inability of children six years or older to maintain a good prone extension position for 30 seconds is suggestive of a vestibular system processing inefficiency, and warrants further testing. Obtaining qualitative norms for a broader socioeconomic population and for five-year-old children is necessary.

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