DEVELOPMENTAL EYE MOVEMENT TEST (DEM)
(Reprinted from Pacific University College of Optometry Visual Perceptual Testing Manual, Editor: Hannu Laukkanen, OD, Med, FAAO)

Purpose: The DEM provides the clinician with an objective measure on a child’s eye movements and oculomotor ability. The author states that it can provide the practitioner feedback on "how the reader processes visual information during reading and non-reading tasks." 1

Indications: The DEM is normed for children ages 6 - 13. It should be administered to children whom the practitioner suspects decreased reading skills due to deficiencies in oculomotor skills.

The DEM manual:

Apparatus and Setup: DEM test booklet, test blank for recording performance, and a stop watch.

Time Required: Approximately five minutes for explanation and performance.

In an effort to maintain test validity and reliability, the following administration and scoring instructions are adapted directly from the test manual for the Developmental Eye Movement Test. Proper use of the test requires the purchase of the Developmental Eye Movement Test and adherence to the protocol listed in the test manual.

Preset (Administration): The DEM consists of three sub-tests (A, B and C). The three sub-tests must be given in specific order. Subtests A and B are the vertical components, sub-test C being the horizontal component.
**TEST A:**

![Test A Image]

**Pre-test:** The pre-test should be administered to all children 6 years of age. Say, "See this row of numbers? Please say these numbers out loud for me". The child should be able to read the row aloud in 12 seconds or less. The examiner should not provide any prompting. Finger pointing is allowed during the pre-test. It is a test of number knowledge and articulation and if the child is unable to perform this task, the DEM should not be administered.

**Vertical Test:** Place test plate A before the patient. Say, "I want you to carefully read the numbers down the two columns like this as quickly as you can". (Point to the top of the first column and motion with finger down the column. Repeat for the right column). Finger use is not permitted on this portion of the test. Tell the child, "Do not use your finger. Use only your eyes". Record the time it takes to complete Test A on the test blank.

Place test B before the patient. Administer exactly as test A. Record the time it takes to complete test B on the test blank.

**Horizontal Test:** Place test plate C before the patient. Say, "I want you to carefully read the numbers across the rows like this as quickly as you can." (Point to the first number of the top row. Motion with your finger along the line from left to right. At the end of the first line, motion finger to the beginning of the second line. Continue this for the next two lines). Make sure the child understands to continue the test upon completion of one row without interruption to the bottom of the page. Record the time it takes to complete test C on the test blank.
TEST C:

Scoring: Vertical time score is determined by adding the time to complete tests A and B. Record this time on the test blank. The vertical time score helps to determine the child's automaticity of number calling ability.

Horizontal time score is determined by adjusting the time to complete test C by compensating for errors of omission and addition. The time is adjusted upward when numbers are omitted and downward when more than 80 numbers are read. The Horizontal Time is a measure of number calling ability in a horizontal spatial array. Several components may be contributing to performance on this task (short term visual memory, attention, spatial awareness). Therefore, it is important to differentially diagnose and assess other potential areas of possible deficiency. The formula for adjusting the Horizontal time score is as follows:

\[
\text{Adjusted Horizontal Time} = \frac{\text{Raw Score} \times 80}{80 - \text{Additions} + \text{Omissions}}
\]

The Ratio score is determined by dividing the adjusted Horizontal Time by the Vertical Time. Ratio scores which are higher than the expected normal values suggests number calling with horizontal eye movements are more difficult for the patient as compared to calling the same amount of numbers in a vertical array. From the Ratio score, four clinical response types have been identified:

a) Type I Behavior:
Essentially normal performance in Horizontal Time, Vertical Time, and Ratio.

b) Type II Behavior:
Characterized as abnormally increased time to complete the Horizontal Test in the presence of normal performance on the Vertical Test. The Ratio would be abnormally high in this case. Type II behavior is characteristic of oculomotor dysfunction.

c) Type III Behavior:
Typified as an abnormal increase in both the Horizontal Test and Vertical Test times, but with a normal Ratio. In the presence of a normal Ratio, the Horizontal Test time is influenced and increased because of an abnormal baseline. This represents a case of difficulty in automaticity in number calling skills, not an ocular motility deficit.
d) Type IV Behavior:
Increased Horizontal and Vertical Test times, and an abnormally high Ratio. This case is a combination of Type II and Type III behavior patterns. There are deficiencies in automaticity/oculomotor skills.

### Normative Age Equivalent performance for the DEM test:

<table>
<thead>
<tr>
<th>Age</th>
<th>Vertical Time (seconds)</th>
<th>Horizontal Time (seconds)</th>
<th>Errors (Mean (S.D.))</th>
<th>Ratio (H/V) (Mean (S.D.))</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.0 - 6.11</td>
<td>63.11 (16.59)</td>
<td>98.26 (32.61)</td>
<td>15.22 (11.49)</td>
<td>1.58 (0.45)</td>
</tr>
<tr>
<td>7.0 - 7.11</td>
<td>54.83 (9.20)</td>
<td>87.94 (28.18)</td>
<td>12.50 (12.91)</td>
<td>1.60 (0.41)</td>
</tr>
<tr>
<td>8.0 - 8.11</td>
<td>46.76 (7.89)</td>
<td>57.73 (12.32)</td>
<td>4.61 (6.91)</td>
<td>1.24 (0.18)</td>
</tr>
<tr>
<td>9.0 - 9.11</td>
<td>42.33 (8.20)</td>
<td>51.13 (13.30)</td>
<td>2.17 (4.10)</td>
<td>1.21 (0.19)</td>
</tr>
<tr>
<td>10.0 - 10.11</td>
<td>40.28 (7.43)</td>
<td>47.64 (10.11)</td>
<td>1.91 (2.68)</td>
<td>1.19 (0.17)</td>
</tr>
<tr>
<td>11.0 - 11.11</td>
<td>37.14 (5.42)</td>
<td>42.62 (7.61)</td>
<td>1.68 (2.34)</td>
<td>1.15 (0.13)</td>
</tr>
<tr>
<td>12.0 - 12.11</td>
<td>35.14 (5.87)</td>
<td>39.35 (8.11)</td>
<td>1.11 (1.17)</td>
<td>1.12 (0.10)</td>
</tr>
<tr>
<td>13.0 - 13.11</td>
<td>33.75 (6.53)</td>
<td>37.56 (7.23)</td>
<td>1.61 (2.15)</td>
<td>1.12 (0.12)</td>
</tr>
</tbody>
</table>

### What to Look For:
Substitutions, omissions, additions and transpositions. For the horizontal portion of the DEM, these errors are to be marked on the test blank. Errors need not be accounted for on the vertical portion of the test. If an entire line is skipped, count each number (5 omissions) when using the formula for adjusting Horizontal Time, but when recording "total errors", the whole line omission only counts as one error.
The DEM Recording Sheet (PUCO version):

**Critique:** Test-retest reliability as reported by the authors of the DEM was 0.89 for vertical time scores, 0.86 for horizontal time scores, and 0.57 for ratio scores. Inter-examiner reliability was determined to be 0.81 for vertical time scores, 0.91 for horizontal time scores and 0.57 for the ratio score. Error coefficients on both test-retest and inter-examiner were not significant, at 0.07 for each.

It has been theorized by Gilbert that the control used in making eye movements closely approximates that which is used in reading.\(^2\) Therefore, Gilbert states the DEM is a good test to use clinically to evaluate eye movements. In research conducted by Kulp and Schmidt, their findings suggest that the DEM is too difficult a test for most kindergartners. They also state the DEM is able to factor out the automaticity of number knowledge.\(^3\)
Rouse et al evaluated the test-retest reliability of the DEM in a population of thirty 3rd grade students. Results showed moderate correlation for vertical (r=0.65) and horizontal (r=0.58) times, while the ratio score's reliability correlation (r=0.196) was very low.

**Survey Results (1997):**
How often used: 3.36. 46 of the total 91 responding optometrists reported using the DEM “all the time” or “frequently”.

Usefulness: 4.20. 50 of the responding optometrists indicate they feel the DEM is “extremely” or “very” useful.

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**References:**