Accommodative rock: a normative study on a grade school population

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Abstract

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ACCOMMODATIVE ROCK: A Normative Study on a Grade School Population

Submitted in fulfillment of the requirements for Opt. 692

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Submitted by
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David J. McBride
We would like to express our sincere appreciation to the Forest Grove School District for all of their help and cooperation during the school screenings and this research thesis.
ABSTRACT

A general vision screening was performed on 566 1st and 4th grade school children from which the accommodative rock test was normed. The procedure consisted of a ± 2.00D lens flipper, recording the number of lens flips for a one minute testing. This included an intermediate count taken after the first 30 seconds and a final total count after 60 seconds. A significant difference of the normative means was found between the 1st and 4th grade population. No significant difference was found within each population between those who passed and those who failed the general screening, or between the first 30 seconds and the final 30 seconds of testing.

Key words--- Accommodative rock, lens flipper, accommodative facility, lens rock.
An optometrist is often faced with an examination of a child who reports a list of complaints such as the print at school blurs while reading, eyes tire easily, eyes hurt or are red. The parents often report that the child holds reading material excessively close. These signs and symptoms may be indicative of an accommodative dysfunction, quite often considered to be accommodative infacility.

Accommodative facility is the ability to stimulate and relax accommodation for a specific task. Pierce and Greenspan (1) state that accommodative infacility is a very common problem in non-presbyopes. "When problems in accommodative inflexibility are found, accommodative rock procedures in vision training constitute the principal avenue of treatment." (1) The question now arises as to what method of testing best quantifies accommodative infacility. For the doctor, a method of testing accommodative facility quickly and easily seems to be the accommodative rock technique, consisting of a timed test requiring both speed and
The values are generally recorded in cycles per minute (cpm). A cycle as defined by Pierce is two fixations, one stimulating accommodation and the other relaxing accommodation.

Cline and Smith (2) tested the validity of accommodative rock measurement on an adult population. They found that by using a ±2.00D lens flipper, the results obtained from one day to the next were insignificantly different.

Since the binocular rock technique proved to be a reliable test, normative values need to be determined. This is where there seems to be much disagreement. The literature indicates many variables with testing techniques such as target size and contrast, lens power utilized, suppression controls and subject age.

Borish (3) states that a normal subject should be able to clear +1.50D to −2.00D in less than five seconds, with monocular findings within 0.5 seconds of each other. Liu et al. (4) reported that with ±1.50D lens flip a normal subject should be able to obtain clear vision in less than 4.5 seconds with each flip.

Pierce and Greenspan (1), using ±2.50D lens, found normal findings of 20 cpm, monocularly and binocularly on an adult population. Hoffman et al. (5), also using ±2.50D lens, examined 80 school age children. They found monocular values of 2-4 cpm and binocular values of 1-2 cpm. Griffin et al. (6) using a monocular ±2.00D lens rock with subjects between 20-35 years of age, found a mean value of 17 cpm. Hoffman and Rouse (7) state that using a ±2.00D lens flipper, a value of less then 12 cpm with the patient viewing a 20/30 visual acuity demand row of
letters at 16 inches indicate accommodative difficulties when associated with symptoms. Zellers et al. (8) established a mean of 11±5 cpm monocularly and 8±5 cpm binocularly using ±2.00 D lens at 40 cm. with 20/30 demand letters in subjects between the ages of 18-30. In Schlange's et al. (9) paper of norming accommodative facility using 1st, 3rd, and 5th grade students they found no significant difference between each grade level with a 7±3 cpm as their normative value.

The binocular accommodative rock test is being utilized more and more in our clinics for both diagnosing and treating of accommodative infacility. This paper will determine a normative value for accommodative facility using a binocular lens rock technique on 287 first grade and 186 fourth grade subjects. We will hypothesize that there will be no significant difference between the 1st and 4th grade population normative values, and there will be no significant fatigue effect between the first 30 seconds and the last 30 seconds in testing.

**METHOD**

The study population consisted of 326 1st and 230 4th grade students from the Forest Grove School District. Normative values were only taken from subjects who had passed the normal Pacific University College of Optometry (PUCO) screening battery, and obtained 100 arc seconds of stereo acuity. [APPENDIX 1] The testing material consisted of a lens flipper, a target, a score sheet and stopwatch. A ±2.00D lens flipper was used in
conjunction with a target sheet held at 40 centimeters. This sheet was comprised of lower case pica typed letters on a standard 8 1/2x11 inch sheet of white paper. Each letter was separated by a single space and the lines doubled spaced to avoid confusion [APP. 2]. Standard illumination of 10 to 15 footcandles was used.

Subjects were instructed to keep the letters clear and single through the +2.00D lenses. They were then told to call it out loud after which time the examiner flipped to the -2.00D lens. Speed was encouraged during these proceedings without compromising their accuracy. A practice session was performed using sample letters until the procedure of the test was understood. Once the instructions were clear, the timer was set and the testing began. The testing was continued for one minute with an intermediate count taken after the first 30 seconds and a final total count after 60 seconds. It was determined that the examiner would flip the lenses to maintain uniformity in the testing procedure, and to eliminate potential effects of any motor difficulties the child may have.

To score the test, the examiner was to follow along with the child on a separate score sheet marking any omission, additions or mistakes. The score was determined by counting the total number of letters called out, omitting the mistakes or omission and adding any repetitions. A score of zero was given if clarity and fusion was never attained.

The test was performed binocularly so as to best emulate a typical classroom environment. The subject’s habitual near point prescription was worn for all testing.
RESULTS

Tables 1 and 2 show the normative values obtained, and the distribution of the values on the 1st and 4th grade population. The normative data based on those subjects who passed the general screening is indicated by the symbol "P". Those subjects who failed the general screening are indicated by the symbol "F". The mean and standard deviation values are for the total number of lens flips per time interval.

The correlation statistics between the 1st and 4th grade normative data are shown on Table 3. A t-test was utilized to obtain the correlation findings with a hypothesized difference assumed to be zero.

DISCUSSION

The research population consisted of 326 1st and 230 4th grade students, of whom 287 1st and 186 4th grade students passed the general Pacific University College of Optometry screening. Only data from the 475 subjects who met the general screening criteria was utilized in the norming process. The normative value for binocular accommodative rock technique was determined by using the mean number of lens flips for 30 and 60 seconds. From this analysis, we have determined that a value of $10.23 \pm 3.45$ clear fixations ($5.12 \pm 1.73$ cpm) for the 1st grade at 30 seconds and $18.32 \pm 6.18$ clear fixations ($9.16 \pm 3.09$ cpm) at 60 seconds. The 4th grade data show $15.49 \pm 5.56$ clear fixations ($7.75 \pm 2.78$ cpm)
at 30 seconds and 28.17 ± 9.47 clear fixations (14.09 ± 4.74 cpm) at 60 seconds.

A t-test was utilized to correlate the number of clear fixations at 30 and 60 seconds to see if there is a significant difference between the 1st and 4th grade subjects. Comparing data from the 1st grade subjects who passed the general screening criteria with those from the 4th grade, we found a significant difference in normative values at the p<.001 level. This level of significance was the same when comparing the 1st and 4th grade subjects who failed the general screening criteria (p<.001).

Our data indicates that the normative value for the 1st grade population agrees closely with the results from Schlange et al. (9). However, our 4th grade population demonstrates a quicker response time to the rock technique. This differs from Schlange’s research in that he found no significant difference between his first, third and fifth grade subjects.

One variable which may have contributed to this difference in results could be attributed to letter recognition. Some of the 1st grade population experienced difficulty in having to call out specific letters in the testing, therefore slowing down response time. Other variables include uncontrollable distractions due to the screening environment, and an opportunity for the subject to view the letters between each flip. These variables were monitored closely, therefore keeping them to a minimum.

There was no significant difference between the first 30
seconds and the final 30 seconds showing no fatigue effect for a one minute test. There were no significant differences between those failing or passing the general screening criteria.

CONCLUSION

The accommodative rock test is normed for a population of first and fourth grade students. The normative values are shown for those who passed the general screening criteria and for those who failed. There is a significant difference between the norms for the first and fourth grade population. There is no significant difference on the accommodative rock test within each population between those failing or passing the general screening criteria.

Finding a difference in normative values between the 1st and 4th grade population may suggest a need to investigate further to determine if each grade level presents with a different normative value for a binocular rock technique. Data collected on an adult population should not be utilized to determine accommodative facility dysfunctions in a grade school population.
## TABLE 1

Accommodative Rock Normative Values

<table>
<thead>
<tr>
<th></th>
<th>1st P</th>
<th>1st F</th>
<th>4th P</th>
<th>4th F</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACCOM 30 (# of clears)</td>
<td>N=287</td>
<td>N=39</td>
<td>N=186</td>
<td>N=44</td>
</tr>
<tr>
<td></td>
<td>x=10.23</td>
<td>x=9.18</td>
<td>x=15.49</td>
<td>x=16.68</td>
</tr>
<tr>
<td></td>
<td>s=3.45</td>
<td>s=3.98</td>
<td>s=5.56</td>
<td>s=7.04</td>
</tr>
<tr>
<td>ACCOM 60 (# of clears)</td>
<td>N=287</td>
<td>N=39</td>
<td>N=186</td>
<td>N=44</td>
</tr>
<tr>
<td></td>
<td>x=18.32</td>
<td>x=16.56</td>
<td>x=28.17</td>
<td>x=29.52</td>
</tr>
<tr>
<td></td>
<td>s=6.18</td>
<td>s=6.74</td>
<td>s=9.47</td>
<td>s=12.43</td>
</tr>
</tbody>
</table>

N = The sample number  
\( \bar{x} \) = The average number of clear fixations  
\( s \) = The standard deviation  
1st P = The first grade population who passed the screening  
1st F = The first grade population who failed the screening  
4th P = The fourth grade population who passed the screening  
4th F = The fourth grade population who failed the screening  
ACCOM 30 = Accommodative rock after the first 30 seconds of testing.  
ACCOM 60 = Accommodative rock after 60 seconds of testing.
TABLE 2

ACCOMMODATION

FLIPS PER 30 SECONDS

ACCOM 30

0-3 4-7 8-11 12-15 16-19 20-23

0 10 20 30 40 50 60 70 80 90 100

# OF 1ST GRADERS

ACCOM 60

0-7 8-15 16-23 24-31 32-39

0 10 20 30 40 50 60 70 80 90 100

# OF 4TH GRADERS

FLIPS PER 60 SECONDS

ACCOM 30

0-5 6-11 12-17 18-23 24-29 30-35

0 10 20 30 40 50 60 70 80 90 100

# OF 1ST GRADERS

ACCOM 60


0 10 20 30 40 50 60 70 80 90 100

# OF 4TH GRADERS
### TABLE 3

**Accommodative Rock Correlational Statistics**

The following statistics were obtained by using a T-Test in which the hypothesized difference is assumed to be zero.

<table>
<thead>
<tr>
<th>Accommodation 30 Seconds (Number of clears)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st passed vs 1st failed</td>
<td>p = 0.0851</td>
</tr>
<tr>
<td>4th passed vs 4th failed</td>
<td>p = 0.6255</td>
</tr>
<tr>
<td>1st passed vs 4th passed</td>
<td>p &lt; 0.001</td>
</tr>
<tr>
<td>1st failed vs 4th failed</td>
<td>p &lt; 0.001</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Accommodation 60 Seconds (Number of clears)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st passed vs 1st failed</td>
<td>p = 0.0976</td>
</tr>
<tr>
<td>4th passed vs 4th failed</td>
<td>p = 0.4498</td>
</tr>
<tr>
<td>1st passed vs 4th passed</td>
<td>p &lt; 0.001</td>
</tr>
<tr>
<td>1st failed vs 4th failed</td>
<td>p &lt; 0.001</td>
</tr>
</tbody>
</table>
APPENDIX 1

PACIFIC UNIVERSITY COLLEGE OF OPTOMETRY VISION SCREENING PROGRAM - CRITERIA FOR REFERRAL

* A. Visual Acuity (Near or Far): worse than 20/30, either eye

* B. Refractive Error:
  1. Hyperopia
  2. Myopia
  3. Astigmatism
  4. Anisometropia

* C. Two-Eyed Coordination:
  1. At Distance (20 feet):
     a. Tropia
     b. Esophoria
     c. Exophoria
     d. Hyperphoria
  2. At Near (16 inches):
     a. Tropia
     b. Esophoria
     c. Exophoria
     d. Hyperphoria

* D. Ocular Health: Any verified pathology or medical anomaly of eye and/or adnexa

* E. Ocular Pressure (if tested):
  1. Measured IOP 26 mmHg or greater
     (Borderline IOP: 22-25 mmHg)
  2. IOP(right) - IOP(left) 6 mmHg or greater
     (Borderline: 4-5 mmHg)

F. Near Point of Convergence (NPC):
  1. Break (recorded in inches)
  2. Recovery (recorded in inches)

G. MEM Retinoscopy:
  1. 20/300 Snellen numbers
  2. 20/30 Snellen letters

H. Stern-Fixation Test:
  1. Level 1 (First through third graders)
  2. Level 2 (Fourth graders and older)

I. Lens Rocks (+/-2.00D): Recorded number of clears in 30 and 60 seconds.

J. Prism Rocks (8 BI/BO): Recorded number of clears in 30 and 60 seconds.

Table 1: * A-E were used to determine pass/fail criteria. Tests F-J were used in screening study to develop normative data and were not used for referral.
ACKNOWLEDGEMENTS

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REFERENCES


