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VISUAL ACUITY SCREENING IN THE PRESCHOOL POPULATION: A COMPARISON OF TWO TESTS

By

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LINDA R. MEDESKI

A thesis submitted to the faculty of the
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BIOGRAPHIES

Michael McCown grew up in a small town in Alaska, graduated from Soldotna High School, attended the University of Washington in Seattle, where he completed his pre-optometry requirements. He earned his B.S. in Visual Science from Pacific University, and plans to practice in the Northwest in a functionally oriented optometric practice upon completion of his optometric studies.

Linda Medeski, originally from Thornton, Colorado, attended the University of Colorado at Boulder. She then entered optometry school after three years of undergraduate work and received her Bachelor of Science in Visual Science from Pacific University. Following graduation from the Pacific University College of Optometry in May of 1990, she plans to practice in the Pacific Northwest.

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ABSTRACT

Acuity measurement in adults is generally done with the Snellen acuity chart, however, acuity assessment in preschoolers must often utilize alternative methods. This study compared the Light House Acuity Test to the Broken Wheel Acuity Test to determine whether or not the Broken Wheel Acuity Test is a viable test for assessment of visual acuity in the preschool population in a screening situation. Results indicate that the tests have good correlation of acuity values and both procedures yielded high testability rates. Four year old children showed slower testing time than five year old children, but there was no significant difference in final acuity reached. Final choice of visual acuity screening tests should be based on individual responses of the child and on the individual preference of the examiner.

INTRODUCTION

The early detection and treatment of vision anomalies is a primary goal of practicing optometrists and determining a patient's visual acuity is an imperative component in reaching this goal. The Snellen acuity chart is generally used to obtain visual acuity in adults and can be used in children who know and can identify the alphabet. Generally, preschoolers, ages 3-5 years, do not know the alphabet well, and thus, can not respond well to the Snellen charts. Children in this age group often require an alternate method of Visual Acuity (VA) assessment. Determining which test to use has posed a great challenge to professionals working with preschoolers. There are a variety of tests available for use, and they fall under one of five general types of symbols: Tumbling E, Picture/symbol, Grating, Minimum Discernable, or Landolt C. [1] The Tumbling E test places the letter E or variations of it into various positions in which the child is to respond by indicating the direction of the E. This can be modified by asking the child to match the orientation of a cut-out E to the E shown on the screen. Some norms have been established for this test in this age group.[4] One disadvantage of this type of test is the need for a developed sense of directionality by the child. This becomes critical when the evidence shows that horizontal directionality develops later than vertical directionality.[5,8] At this age,

directionality may have a direct bearing on the way the child performs on these tests and the way the results are interpreted.[5] If a correct response is given, it is assumed that the child not only saw the picture, but was also able to interpret it. An incorrect response, however, poses problems of whether the child failed to see the picture or was just unable to interpret or communicate what was actually seen.[8] Another disadvantage of the Snellen E is that it does not provide an interesting target for children of this age. It has been shown that this test failed to hold the interest of the preschool patient.[6]

Picture/symbol optotypes are visual acuity tests made up of pictures that should be familiar to children. They are recognition/resolution tests and there are many variations of this optotype; Osterberg and Allen charts are two popular types in this category. The Light House acuity test also uses pictures to assess VA and consists of three pictures; a house, an apple and an umbrella. Although this test has been used to evaluate acuities in preschoolers, norms by age have not been established. A study using preschool children compared the results of the Light House acuity test to the results of the Snellen acuity measurement when the children were older[1]. The Light House test was first performed on preschool children and then repeated on the same children after they had learned the alphabet. The results indicate that the Light House test provides the "...highest degree of accuracy possible with symbols."[6]

High contrast gratings of varying spatial frequencies have been used to assess visual acuity.[14] This type of task is a resolution acuity task. The childs task is to find the target on a homogenous, luminance matched background. This technique has been formalized using the Forced Preferential Looking paradigm, and modified in the "acuity card procedure"[13,14,15]

The minimum discernable technique is exemplified by the Kirschen Dot and Bock Candy Bead tests. These involve use of an increasingly smaller object that young children are asked to reach out and touch or pick up. The candy bead test is highly subjective since pieces of the candy are broken into "roughly" equal parts and it is assumed if the child is able to see the candy he will reach directly for the candy and pick it up.[3] The Kirschen Dot test attempts to standardize the acuity level by printing dots of known size instead of using candy. Norms for VA when compared to Tumbling E have been published.[16]

The Landolt C optotype has been accepted as the standard test optotype by the Committee on Vision of the National Academy of Science-National Research Council.[1,7] The test uses a series of C's in which the patient must determine the direction of the "break" in a C presented in one of four directions. Broken Wheel Visual Acuity test is a modification of the Landolt C which utilizes a two alternative, forced choice acuity task. The BW is a relatively new test (1984) available for use with 3-5 year old patients. The test has proven to be a reliable method of VA assessment for the

proposed age group.[2] An advantage of the Broken Wheel is that it is primarily a test of visual acuity measurement. It factors out the possibility of difficulty with character recognition and the need for well developed directionality and verbal skills that are required in the Tumbling E, Landolt C, and picture type tests. Established norms have not been published for the Broken Wheel.

Vision screenings at the Pacific University College of Optometry have traditionally used the Light House, back-illuminated, acuity test at 10 feet to obtain VA in children between the ages of 3-5 years. A review of the literature supports the use of both the Light House variation of the picture/symbol optotype and the Landolt C optotype for use in the preschool population. Since the Broken Wheel acuity test is a new and possibly easier to use variation of the Landolt C type of acuity test, questions arise as to the impact this test will have on the task of obtaining VA in the preschool population. Considering the reported advantages of the Broken Wheel test, such as being non-verbal and non-directional, this study was designed to determine whether or not the Broken Wheel acuity test is a viable test for the assessment of VA in the preschool child in a screening situation. The Broken Wheel Visual Acuity test was compared to the Light House Visual Acuity Test, which has already been successfully utilized and accepted as a reliable means of VA assessment on preschool screenings. [1,6] Both the Light House and Broken Wheel tests were performed on 123 children ages 3-5 years old to determine; if the two tests measured equal acuities; if time was

an important factor between the tests; and if examiner variability affects the results of the test.

METHODS AND PROCEDURES

Two tests of visual acuity were conducted during the course of four standard preschool vision screenings by Pacific University College of Optometry. A total of 126 preschool children, ages 47-66 months from four local Head Start Programs were tested.

At the beginning of each screening sequence, the child's name and date of birth were recorded. The test distance for both tests was 3 meters. Elapsed time was recorded from the first instruction to the final determination of binocular acuity for each test. Both monocular and binocular acuities were performed.

The Lighthouse Visual Acuity test (LH) procedure involved occlusion of the left eye with a hand held occluder after which the child was asked to identify the three largest optotypes to ascertain the childs description of each type. Recognition was indicated by an appropriate and consistently used name for each of the pictures. Then, successively smaller targets were pointed to by the examiner, and maximum acuity was recorded as the smallest line in which the child was able to correctly identify over half of the optotypes. The acuity for the left eye and binocular acuities were then completed in the same manner.

The Broken Wheel Visual Acuity Test(BW) procedure involved presenting the demonstration cards and asking the child to identify which of the two cards had the broken wheels. For those who did

not notice a difference or were reluctant to speak, the difference between the "broken" and "whole" wheels was further explained. Several trials with the demonstration cards were run to insure that the child understood the task and could respond with either a verbal and pointing response, or a pointing response only. Right eye acuities were performed by occluding the left eye with a hand held occluder, and the acuity demand was increased with each correct response in which the child was obviously responding to the acuity demand. When the first incorrect response was encountered, the preceeding acuity demand was then retested with four trials to verify the previous response. If the four trials were completed correctly, the next higher demand was retested with another four trials. The last demand level with four correct responses was recorded as the visual acuity. The procedure was repeated for the left eye and binocularly.

The incident lighting was judged to be standard room illumination, however, no photometric readings were taken. There are three distinct differences between the LH and BW tests that should be noted. The LH test used was illuminated from behind while the BW test relied solely on incident lighting to the front of the cards. The BW test consists of two isolated cards for each acuity demand, held approximately 3 feet apart, whereas the LH test utilizes rows of symbols all on the backlit screen.

Finally, measureable acuity levels were slightly different for the two tests. LH measured Snellen equivalents of 20/200, 20/100, 20/70, 20/50. 20/40, 20/30, and 20/20. The BW identified eight

levels of acuity; 20/120, 20/100, 20/80, 20/60, 20/40, 20/30, 20/25, and 20/20.

Approximately half of the children were tested using the LH first, while the other half began with the BW. Each of the examiners conducted approximately 50% of the trials in each test.

RESULTS

The mean age of the 123 children tested was 56.24 months, ranging from 47 to 66 months. The acuity measurements from each of the monocular LH tests were not significantly different from either of the monocular BW tests ([A],$p>.01$), likewise, there was no discernable acuity difference when the binocular LH test was compared to the binocular BW test ([A],$p>.01$). All monocular acuities, however, were significantly different ([A],$p<.01$) from binocular tests acuities for both testing procedures.
(see FIGURE 1.).

In individual cases the BW test gave one acuity interval[C] better acuity than LH on 20 patients, and showed two intervals better on 15 patients. There was one patient where four intervals better acuity was measured with the BW when compared to the LH.

The LH had 18 individual patients who recorded one acuity interval better, 10 patients demonstrated two intervals better, and there were 2 patients who had four intervals better acuity on the LH, when compared to the BW test.

The average time required for the LH test was 138 seconds. While the BW test took an average of 153 seconds. This time was found to be significantly different ([B], $p<.01$). The average time for

both tests decreased steadily as the child became more acquainted with the test. This can be seen from the decreased time from OD to OS to OU tests. (see FIGURE 2).

The time taken to complete the BW test was significantly longer for 4 year olds,(158 sec., SD 49 sec.) compared to 5 year olds (132 sec., SD 35 sec.),(^{B},$p<.01$). This was also seen with the LH test where 4 year olds (144 sec., SD 53 sec.) recorded much slower time than 5 year olds (118 sec., SD 47 sec.),(^{B},$p<.01$). There was, however, no statistical difference (^{B},$p>.05$) for the 4 year old children compared to 5 year old children on the basis of final acuity reached. (see FIGURE 3).

Inter-clinician variability showed no significant difference (^{B} ,$p>.05$) in final acuity values when the two tests were compared. One examiner showed much faster times on the LH (^{B},$p<.01$) when compared to the BW, but the second examiner did not have a significant difference between the times taken to administer each test (^{B},$p>.05$).

There were 120 children who completed all sections of the LH test (97%), while 115 of the children successfully completed all portions of the BW test (93%).

DISCUSSION

The objective of this study was to evaluate the BW on a pre-school population in screening situations. BW was compared to LH because LH is known to be a reliable source of VA assessment on

screenings of pre-school children[6] and is a routinely used test on Pacific University screenings. Since the BW eliminates the need for well developed verbal and/or directionality skills and solely emphasizes visual acuity, we expected the BW to be an excellent VA test and thus, yield higher testability and more accurate acuities than the LH.

The results of the monocular acuities taken with each test were not significantly different. Likewise, the binocular results for each test also yielded similar values. There is, however, significant difference between monocular acuities and binocular acuities for both tests. This difference was expected and can be attributed to various factors. Children at this age do not like to be monocularly occluded and tend to pay more attention to the occluder than the acuity task itself. It is also known that a functioning binocular system is a more efficient means of processing information than is a monocular system. This phenomenon is known as binocular summation.

The average time to administer each test was significantly different, with the BW taking a longer time to complete. This can be attributed to the fact that there are more intervals of acuity measurable with the BW than the LH and the instruction set is somewhat longer for the BW. The time for both tests steadily decreased with each day's administration indicating that after the test is used a number of times, the examiner becomes familiar with the procedure and can adopt strategies that will decrease the administration time. When the time to complete both test was compared by age, the 4 year-olds took a significantly longer time to

complete both tests than the 5 year-olds. Although slower, the time factor did not affect the 4 year-old's maximum final acuity, since there was no significant difference between the end point acuities reached by both age groups. One year's difference in maturity can account for the slower time in the younger group, as the four year olds required a more in depth instruction set, had shorter attention spans, and slower responses. The end point acuities were not significantly different and one can conclude that although the time to administer each test will generally be longer in 4 year-olds, both the BW and LH tests are equally reliable means of VA assessment.

Both tests showed a high percentage testable, but there were some children who responded better to one test than to the other. Some children, especially those with a reserved disposition, reacted well to the BW, making a game of pointing to the particular cards. When tested with the LH, these same children seemed to withdraw when asked to respond by speaking aloud. Conversely, there were several of the more socially mature children who responded extremely well to either test, but, due to the procedures involved, were able to complete the LH faster.

There was significant inter-clinician variability in the time taken to administer each test. This variability did not affect final acuity, since the comparison showed no significant difference in acuity measured by each examiner. Variability in time to administer the tests is expected due to individual differences in style and patient interaction.

This study began as an attempt to determine the usefulness of the BW as a screening test of VA. From these trials we have

reached several conclusions. Similar acuities for each test indicate good correlation between tests for acuity values. In addition, both procedures yielded high testability rates and should not be differentiated on this criterion alone. Individual patients seem to show a preference for one test over the other, and since some children in this study responded slower than others, having both techniques available may lead to faster screenings. The time to administer the tests will vary between clinicians, and each clinician's time will change as they become familiar with the procedures involved with each test. The particular age of the population tested will also affect the overall testing time. The BW does take somewhat longer to administer and if time is a critical factor, the LH may be the prefered test. Originally, we expected the BW to prove an easier test of VA in screenings of the preschool population, however, this conclusion cannot be supported by this study. We did conclude that the BW is a useful technique and both the BW and LH tests provide an easy means of screening visual acuity. The choice of test, therefore, should be made based on individual patients and clinician preference.

FOOTNOTES

A using the Fischer PLSD and the Scheffe F-test

B using the paired T-test

C an acuity interval was defined as .5M difference, i.e. 20/30 to 20/40, 20/40 to 20/50, etc.

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FIGURE 1. ACUITY

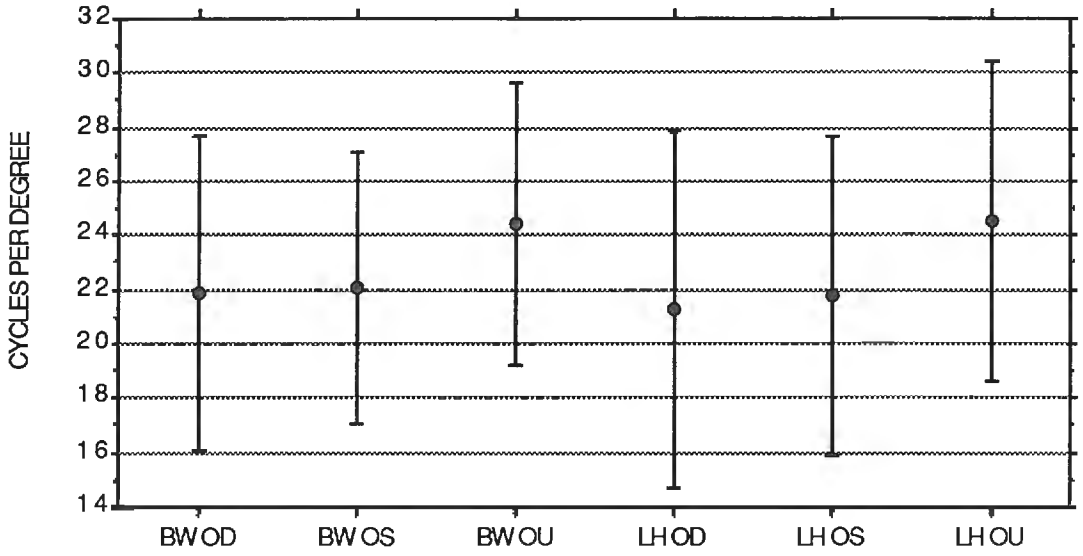

FIGURE 2.

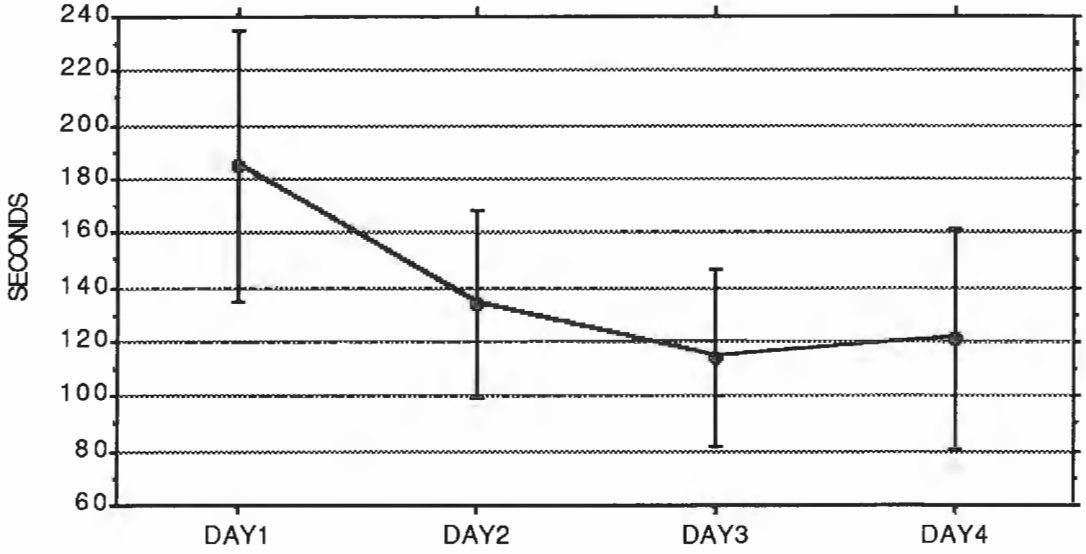
240
220
200
180
160
140
120
100
80
60
SECONDS
DAY1
DAY2
DAY3
DAY4

FIGURE 3. ACUITY BY AGE