

INTRODUCTION OF AN INFANT/PRESCHOOL VISUAL ACUITY TEST
ALONG WITH A COMPARISON OF THE LIGHTHOUSE FLASH CARD SERIES
TO THE SNELLEN ACUITY TEST

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Introduction

The optometrist has been faced with an ongoing problem in testing visual acuity in infants and preschool children. The standard Snellen visual acuity method has obvious drawbacks for use with infants and preschool children due to their lack of letter recognition. The existing two alternatives to this problem are the Lighthouse card series and the Landolt C psychometric series. The psychometric series is generally too time consuming and complicated for practical use with preschool children. The Lighthouse cards seem to be easily understood by children however this method has not been subjected to rigorous comparison with standard visual acuity methods.

The purpose of our study was to establish validity for a modified visual acuity system employing Landolt C's yet eliminating the complexity of the psychometric series. The study also compared the standard projected Snellen acuity chart to the Lighthouse cards. Further we compared the Snellen chart to the modified Landolt C system. Finally the modified Landolt C system was employed with a group of preschool children to establish practicality of the system as well as validity.

The validity and correlation of the Snellen and Landolt C has already been established. However we wanted to compare the Snellen test to the Lighthouse cards to determine any relationship between them. Comparison of the Snellen with the modified Landolt C test was done as a check since we have changed the presentation of the psychometric series to accommodate the preschool child.

The study should more specifically define the use of the Lighthouse card system as it relates to Snellen acuity. It also may define a more precise as well as easily administered visual acuity test for use with preschool children

than the existing Lighthouse series.

Method

Experiment I was designed to standardize tests used on preschool children. It was therefore necessary to use an adult population with known acuities (i.e. based on accepted standards) to judge the tests designed to measure acuity in young children. Forty-four adult eyes were tested, the majority of subjects being students at Ferris State College of Optometry. As optometry students their performance on VA tests is both reliable and critical.

All adult subjects were tested for Snellen acuity at 20 feet utilizing standard practice. Then two methods of testing acuity with Lighthouse cards at 10 feet; and finally using the experimental cards, also at 10 feet. Illumination was held constant throughout all procedures. Right eye was tested first and followed by left eye and both eyes together. All tests utilizing a particular VA test were performed before the next test was started. Ametropic subjects were tested both for naked VA and best corrected VA. Emmetropes were tested with no correction and with varying amounts of plus lens blur (some combined with induced astigmatism). No minus lens blur was attempted. This avoids variability in results due to unstable accommodative effect and the effect of accommodative fatigue on later visual acuity tests. By testing this way we gathered data for comparisons at varying VA levels; not just the 20/15 - 20/20 range.

The experimental cards utilized a target consisting of a black car, truck or train on a white background incorporating either complete circles or Landolt rings as the wheels. The targets were produced by drawing the vehicle without wheels, then prior to photographing the drawing on Kodolith high density film (for maximum contrast and resolution) the wheels were added by transparency overlay. In this manner all vehicles of one type (i.e. cars) were identical with

the exception of the wheels (some being broken, i.e. Landolt C). By varying the distance the photograph is taken from, it is possible to produce targets of any size when developed on prints. Thus, the necessary angular subtents to test a particular VA level at a specified distance can be produced. Relationships of car size to wheel size and wheel size to gap size remains a constant ratio in all targets. This insures no differences in contour interaction between targets at any one acuity level or between the various acuity levels. Ten feet was specified as the test distance for these cards and all cards were produced to yield necessary ring and gap sizes in the Landolt C's for testing each acuity level at the specified distance.

The first part of the experiment compared the standard method of presenting the Lighthouse cards to accepted Snellen acuity. This was done for two reasons. First, to compare the existing standard preschool VA test to the existing standard for VA testing based on an adult population study. Secondly, to provide data for comparison of the experimental method of preschool VA testing to the accepted standard VA tests. Indirectly, therefore, a comparison of the preschool standard (LH) can be made to the experimental method (through the Snellen VA test). Accepted procedures used in our clinic for Snellen VA testing were used.

The standard method of testing using LH cards is, after showing the 3 possible pictures, at nearpoint, to the child, to show one card at a time asking the patient to identify the picture on the card. These cards are designed for use at 10 feet. This is a single choice paradigm and not necessarily the best statistical method for presenting the targets. Theoretically a forced choice method could produce a statistically more reliable VA measurement. This part of the experiment tested that hypothesis.

The adult population was first tested by either the standard single choice (SC) method determining the VA for the right, left and both eyes, then by the

forced choice (FC) method. Approximately half of the subjects were tested by one method first and the remaining half by the other method first. The question asked during SC was "What is this a picture of?", during FC; "Which picture is the house/apple/umbrella?". The response in this method could be verbal, pointing or by attention as in preferential looking (PLT). During FC all 3 cards are held up for viewing and are shuffled between trials.

For a subject to pass a VA level it was necessary to give the correct response 3/3 times in a row (out of 3 trials). This essentially gives a 2/3 test in the SC method since after two have been identified the third is given. No such problem exists in the FC/PLT since each presentation represents a choice between all 3 cards. The chance of a totally blind person passing an acuity level based solely on guessing is $4\frac{1}{2}\%$ for the FC method $4\frac{1}{2}\%$ for the SC.

Data was gathered on adults utilizing the modified Landolt C so that conclusions about the reliability of this method could be made. A FC paradigm was used, the choice being between 3 cards. One with Landolt C's (broken wheels, BW) the other two having solid rings (unbroken wheels). First the subject was shown the cards at nearpoint and the task explained to them. They were told "Two of these cars/trains/trucks are all right, the third has broken wheels. Can you point to the one with broken wheels?". Upon correct identification of the target with broken wheels the targets were taken to 10 feet and repeated with a large set of targets to be sure the subjects understood the task. Progressively smaller sets of cards were presented (three times at each level the cards being randomly re-arranged between each presentation) until an incorrect response was obtained. The response made can be verbal, pointing or through observation of the subjects eyes, (i.e. PLT). In this experiment either pointing or verbal responses were accepted.

In Experiment II, 46 Head Start children were screened using the BW method as the VA test in the MCT. The same sequence was used with the 4-year-old children as used with the adults in Experiment I. This was to determine how clinically applicable this testing method is with preschool children. The pass/fail criteria was identical to that used with adult subjects. Illumination was held constant throughout all presentations of the test cards. Two examiners were present throughout the tests so that the children would not be ignored during the re-arrangement of the cards and so that the instructions "Point to the picture of the car/truck/train with broken wheels." or the question "Which car/truck/train has broken wheels?" could be repeated prior to each presentation. Obviously two examiners are not necessary to administer the test. Again either pointing or verbal responses were accepted. No time limit for response was imposed on the children since many were shy and obviously afraid of being wrong. Right eyes were tested before left. To motivate the child to participate they were told this was a new game and we were keeping score to see who played the best. This myth was a very good motivator and elicited responses from all members of the group but two. Their lack of response precludes them from this report.

The same Head Start children were also given the Pintner-Cunningham Primary Mental Test. This is a test of verbal intelligence and is a fair predictor of reading success. This test was given to correlate developmental status and VA obtained from the BW test.

Results

Experiment I:

The correlation matrix for the Snellen, LH (SC), LH (PLT), BW comparison are given in Table I. The matrix shows a high correlation between all combinations of VA tests.

The results of the comparison between the BW and Snellen VA test show no

significant ($p > .01$, $r^2 = 0.85$) difference between the two according to the Student t test. The comparison of the LH cards to the Snellen acuity results do show a significant ($p < .001$, $r^2 = 0.75$) difference in clinically measured acuity according to the Student t test.

Experiment II:

Table II is a frequency distribution of VA for the 35 Head Start children tested with the BW cards. The comparison between the Pintner and the BW results shows a negative correlation ($p < .01$) as well as a significant ($p < .01$, $r^2 = 0.26$) between the two results. The comparison of Pintner scores on children with VA of 20/30 or better $N=14$ with Pintner scores on children with VA 20/60 or worse, $N=9$ shows a significant ($p < .01$, $F=3.17$, $df=21$) difference. Of the 25% of the total group who were 20/60 or worse 80% of those children also passed the MCT. All the children were re-tested with the LH cards and passed at the 20/30 level.

Discussion

The results from Experiment I show that the BW test is highly correlated with the Snellen acuity test. Coupled with the fact that there was no significant statistical difference between the scores obtained on the 2 tests shows that the BW test is as valid a measure of acuity as the Snellen chart. This was not a surprising finding since Landolt C's and Snellen's have already been shown to give similar results. Our purpose was to show that the BW test was valid as a psychometric test of VA. Without the comparison the changes in the way the test was presented from the standard psychometric series could have been enough to change the results. However our findings do indicate that the BW and Snellen acuity tests give very similar results. (See Table IV)

The comparison of LH cards, both single cards and PLT, did show significant differences from the Snellen acuity test. While the correlation was high there

was a statistical difference in the measured acuity. Our results show in most cases a 1 1/2 - 2 line difference between LH and Snellen acuity with the LH giving the better acuity result.

The relationship between LH and Snellen acuity is not linear but it does show a pattern. That is, as acuity drops off, especially when worse than 20/40 on Snellen acuity, the LH shows a trend toward better VA and thus farther from the Snellen value. The difference at 20/20 LH is 1 line but at 20/50 LH Snellen acuity would be 3 lines worse. (See Table III)

Experiment II data shows a distribution of VA scores on 35 Head Start children. The data does not deviate from what would be expected from a group of children at this age.

The data from the VA and Pintner scores comparison indicates that as VA decreased the Pintner scores tended to go down. The data also shows that the children with the highest level of VA also scored significantly better on the Pintner tests.

Conclusion

The results of our study indicate that the LH acuity cards for measuring VA was not as valid an indicator as compared to Snellen acuity. The LH cards seem to give the impression that VA is better than would be indicated on the Snellen test. This is not surprising since the LH flash cards inherently have a high recognition factor without any well defined critical detail. They also fail to account for any contour interaction. These problems with the LH are the probable cause of the difference.

The problems with the LH series are not reason to throw the test out. It is an easily administered test and gives reliable results. However, when considering the results, one should keep in mind the differences from Snellen acuity. Because of the differences we suggest 20/25 to be the cut-off criteria

for failure on the MCT. The child should absolutely be failed at 20/30, especially if discrimination skills are relatively normal. The LH can be used but it should be used with caution.

Our study suggests a reliable yet valid alternative to the LH series. That is the BW test. The test we have devised has the necessary ingredients of a good VA test, i.e. critical detail, contour interaction, relatively easy administration, and easily understood by even very young children.

The BW test may prove to be a valuable alternative to the LH flash series. The BW does need more clinical work to discern any problems in the mechanics of administration. The last portion of the experiment did not reveal any major drawbacks with the test as employed with 4-year-old Head Start children. The test theoretically could be done with much younger children and clinical trials with them need to be done.

An interesting aspect of the BW test was the comparison to the Pintner scores. The BW test shows a close relationship with perceptual development, to discrimination and VA level. Perhaps the VA test is measuring both aspects of a child's functioning or that one is dependent on the other. More research into this relationship needs to be done to determine just how closely and in what manner perceptual skills and development are related to VA. The BW test and other tests should be related to strict development tests to determine the relationship.