Validity of a Picture Visual Acuity Test

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Abstract

Picture visual acuity tests are available for most standard vision examination projection charts. These pictures are used with pre-literate patients, mostly the pediatric population. These pictures have been assigned values in Snellen notation, i.e. 20/30, 20/40, etc. This study was designed to determine how well these assigned values correspond to Snellen acuity measurements. Data was obtained from 59 volunteers (however, n for statistical analysis was much lower due to ceiling and basement effects of the picture chart). Acuity was measured unaided using both the Snellen and picture charts. The order of the testing was randomized by both eye and test chart. Each eye served, as it's own control. A correlation was found between the values obtained on the picture acuity chart and the Snellen chart that was significant (r=. 922, t=7.77E-07, two-tailed). However, in 92.7% of the eyes tested, acuity was measured as worse using the picture charts than on the Snellen chart. An average of 0.166±0.108 SD.

Introduction

Ciner [1] and many other authors [2,3,4,5] stress the importance of detecting uncorrected refractive error before it influences development. Specifically related to the development of normal binocular vision (prevention or minimization of amblyopia) and the facilitation of vision related learning. Richman points out that visual deprivation may restrict appropriate sensory, perceptual, and cognitive development.[2]

Before a child is referred for a complete vision exam someone must realize that there is a problem. The child may not be aware that their vision is not right. According to Schmidt[6] 21% of the preschool children in the United States go through a vision screening. Visual acuity measurement in screenings is sometimes the only test[2] done to establish if a student needs to be referred for additional evaluation. It is important for these measurements to be accurate and valid so that the appropriate individuals are identified and further evaluated.[6, 7,2,4] Once treatment is initiated It is important that assessments taken over time are related to treatment plans or disease progression and not variability in the test itself.[8, 9]

Being able to compare to Snellen notation allows the clinician a more concrete understanding of the child's refractive status.[4, 2,7] There has been much research to determine the best way to measure acuity in young children. The

goal is to find a test that is valid and accurate, and will hold the attention of the young child throughout the test. Measuring visual acuity in the preschool population can be challenging due to this population often displaying reduced concentration, co-operation, and intelligence.[10]

Numerous researchers have attempted to design a method to improve the assessment of visual acuity in young children.[3, 10,9,4,2,11,12, etc]

Methods

Data was gathered at the Michigan College of Optometry (MCO) vision clinic using a standard ophthalmic testing lane. Exam rooms and projection charts are regularly calibrated based on the room length. A Topcon ACP-7R visual acuity projector was used to project both a standard Snellen chart and the picture charts. The picture charts range from 20/200 to 20/30 Snellen values. The Snellen letter range from 20/400 to 20/10. Consent to participate in the study was obtained from each subject. Subjects (n=59) were volunteers from the optometry student body at MCO. One staff person also participated. Subjects were asked to remove their corrective lenses (either spectacles or contact lenses). The subject was given a cover paddle and asked to occlude one of their eyes. Using a predetermined random order for each subject, uncorrected visual acuity was measured in both eyes using the picture and Snellen letter charts. Acuity was recorded as the lowest line that the subject got at least 50% of the figures or letters correct.[13] Acuity measurements were converted to LogMar values for the purpose of data analysis. The subjects' refractive status was determined by their current spectacle or contact lens prescription. This refractive status was converted to the spherical equivalent for the purpose of data analysis.

Results

Correlation coefficients and their significance was computed for the subject pool as a whole, and for various sub-groups based on refractive status. A correlation was found between the values obtained on the picture acuity chart and the Snellen chart that was significant (r=. 922, t=7.77E-07, two-tailed). However, in 92.7% of the eyes tested, acuity was measured as worse using the picture charts than on the Snellen chart. The mean difference in acuity in LogMar was 0.166 with a standard deviation of ±0.108. The charts seem to correlate better when evaluating low myopes [-3.75 to –1.75] (r=0.949, t=0.00279, one-tail, n=8), as compared to moderate myopes [-1.875 to –4.75] (r=0.533, t=0.000815, one-tail, n=11). Many data point had to be disregard due to the absolute limits of the picture acuity chart (20/30 to 20/200). [13] Many subjects that were high myopes or emmetropic had to be excluded for those reasons.

Discussion

The Topcon ACP-7R visual acuity picture chart using literate adult patients was almost one acuity line worse in 92.7% of subjects.

Interesting, Jenkins et al. in reference to Allen figures (a different type of picture card) found this type of stimulus (pictures) was also a less reliable measure of acuity than the Snellen letter and in fact was easier to see.[14] Picture charts have also been criticized for not following the 5:1 ratio that Snellen letters were designed to subtend.[7, 2] This ratio has been used to help standardized measurements between charts, and between letters within charts.

Obtaining an accurate measure of visual acuity from preschool children is difficult by nature.[7] The purpose of utilizing pictures in visual acuity measure, beside the ability to test preliterate individuals, includes an increase in the interest of the child.[10] Recognition for pictures depends on the interpretation of the forms, the abstractness of the picture, and familiarity with the object.[3] Picture test require less overall maturity of the subject, which may allow the examiner to approximate the acuity of an otherwise untestable subject. [15] A paper by Sturner, et al. defends picture acuity test as a compromise necessary to minimize the cost of time, material, and manpower required for a more sensitive test.[15] However you must consider that as a test becomes less sensitive the chance for under referrals increases.[6] Consider the cost of missing the opportunity for a adequate education in an intelligent child with a significant refractive error or amblyopia.

References

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Appendices

Statistical

Picture Test Validity				
Subject	Spherical Eq.	Picture	Snellen	
43OD	1.5	0.477	0.398	0.079
43OS	1.25	0.477	0.176	0.301
48OS	-0.375	0.602	0.477	0.125
49OS	-1	0.602	0.477	0.125
35OD	-1	0.301	0.176	0.125
59OD	-1.25	0.176	0.176	0
51OS	-1.25	0.699	0.398	0.301
34OD	-1.5	1	0.875	0.125
59OS	-1.5	0.477	0.301	0.176
06OS	-1.75	1	0.699	0.301
08OS	-1.875	0.602	0.602	0
33OD	-1.875	1	0.875	0.125
49OD	-2	1	0.875	0.125
08OD	-2	1	0.699	0.301
16OS	-2.375	1	0.875	0.125
34OS	-2.5	1	0.875	0.125
22OD	-2.625	1	0.699	0.301
36OS	-2.875	1	0.699	0.301
38OS	-3	1	1	0
36OD	-3	1	0.699	0.301
30OD	-4.75	1	0.875	0.125
			Sum of diff	3.487
			Mean	0.166048
			Std dev	0.107945

correlation all values 0.922265

t-test 7.77E-07 two tailed paired

correlation low myope -.375 to -1.75 0.948719

n=8

t-test 0.00279229

correlation moderate myope -1.875 to -4.75 0.532985

n=11

t-test 0.00081453

Picture Test Validity			
Subject	Spherical Eq.	Picture	Snellen
01OD	-2.375	>1	0.875
01OS	-2.625	>1	0.875
06OS	-1.75	1	0.699
08OD	-2	1	0.699
08OS	-1.875	0.602	0.602
10OS	-5.25	>1	1
15OD	-3.75	>1	1
15OS	-3.75	>1	1
16OS	-2.375	1	0.875
17OD	-2.25	>1	0.875
17OS	-2.625	>1	0.875
21OD	-3.75	>1	1
21OS	-3.5	>1	1
22OD	-2.625	1	0.699
22OS	-2.875	>1	0.699
30OD	-4.75	1	0.875
33OD	-1.875	1	0.875
33OS	-2.5	>1	1
34OD	-1.5	1	0.875
34OS	-2.5	1	0.875
35OD	-1	0.301	0.176
35OS	-0.75	0.301	<0.176
36OD	-3	1	0.699
36OS	-2.875	1	0.699
38OS	-3	1	1
41OD	-3	>1	0.875
41OS	-3	>1	1
43OD	1.5	0.477	0.398
43OS	1.25	0.477	0.176
46OD	-2.75	>1	1
46OS	-2.75	>1	0.875
48OS	-0.375	0.602	0.477
49OD	-2	1	0.875
49OS	-1	0.602	0.477
50OD	-3.75	>1	0.875
50OS	-4.5	>1	0.875
51OD	-1	0.477	<0.176
51OS	-1.25	0.699	0.398
54OS	-3	>1	1
59OD	-1.25	0.176	0.176
59OS	-1.5	0.477	0.301

92.68% of time poorer acuites with pictures
7.32 % equal acuities with pictures

Data points

Picture Test Validity			
Subject	Spherical Eq.	Picture	Snellen
01OD	-2.375	>1	0.875
01OS	-2.625	>1	0.875
02OD	-3.25	>1	>1.301
02OS	-3.125	>1	>1.301
03OD	-7.375	>1	>1.301
03OS	-7.875	>1	>1.301
04OD	-5.75	>1	>1.301
04OS	-5.75	>1	>1.301
05OS	-2.75	>1	1.176
05OS	-3.75	>1	>1.301
06OD	-0.5	0.176	-0.288
06OS	-1.75	1	0.699
07OD	-4.625	>1	1.301
07OS	-3.75	>1	1.301
08OD	-2	1	0.699
08OS	-1.875	0.602	0.602
09OD	-3.75	>1	1.301
09OS	-3.875	>1	1.176
10OD	-6.5	>1	1.176
10OS	-5.25	>1	1
11OD	-6.25	>1	>1.301
11OS	-5	>1	1.176
12OD	plano	0.176	-0.288
12OS	plano	0.176	-0.288
13OD	plano	0.176	-0.693
13OS	plano	0.176	-0.693
14OD	-7.5	>1	>1.301
140S	-8.875	>1	>1.301
15OD	-3.75	>1	1
15OS	-3.75	>1	1
16OD	-3.125	>1	1
16OS	-2.375	1	1.176
17OD	-2.25	>1	0.875
17OS	-2.625	>1	0.875
18OD	plano	0.176	-0.288
18OS	plano	0.176	-0.288
19OD	0.5	0.176	0
19OS	0.5	0.176	0
20OD	-3.75	>1	1.301
20OS	-3.75	>1	1.301
21OD	-3.75	>1	1
21OS	-3.5	>1	1
22OD	-2.625	1	0.699
22OS	-2.875	>1	0.699
23OD	0.5	0.176	0
23OS	0.5	0.176	0
24OD	-5.75	>1	>1.301
24OS	-5.375	>1	>1.301

data points

Picture Test Validity			
Subject	Spherical Eq.	Picture	Snellen
25OD	-2.875	>1	1.301
25OS	-3.375	>1	1.301
26OD	plano	0.176	-0.288
26OD	plano	0.176	-0.288
27OD	-4.75	>1	>1.301
27OS	-4.75	>1	>1.301
28OD	0.625	0.176	-0.288
28OS	0.625	0.176	-0.288
29OD	-7	>1	>1.301
29OS	-6.5	>1	>1.301
30OD	-4.75	1	0.875
30OS	-5.875	>1	>1.301
31OD	-5	>1	>1.301
31OS	-5.75	>1	>1.301
32OD	plano	0.176	-0.288
32OS	plano	0.176	-0.288
33OD	-1.875	1	0.875
33OS	-2.5	>1	1
34OD	-1.5	1	0.875
34OS	-2.5	1	0.875
35OD	-1	0.301	0.176
35OS	-0.75	0.301	-0.0969
36OD	-3	1	0.699
36OS	-2.875	1	0.699
37OD	plano	0.176	-0.288
37OS	plano	0.176	-0.288
38OD	-3.75	>1	>1
38OS	-3	1	1
39OD	plano	0.176	-0.288
39OS	-0.5	0.176	-0.288
40OD	plano	0.176	0
40OS	plano	0.176	0
41OD	-3	>1	0.875
41OS	-3	>1	1
42OD	-0.5	0.176	-0.288
42OS	-0.5	0.176	-0.288
43OD	1.5	0.477	0.398
43OS	1.25	0.477	0.176
44OD	plano	0.176	-0.288
44OS	plano	0.176	-0.288
45OD	-6.75	>1	>1.301
45OS	-7	>1	>1.301
46OD	-2.75	>1	1
46OS	-2.75	>1	0.875
47OD	-4	>1	>1.301
47OS	-4	>1	>1.301
48OD	plano	0.176	-0.288
48OS	-0.375	0.602	0.477

Data points

Picture Test Validity			
Subject	Spherical Eq.	Picture	Snellen
49OD	-2	1	0.875
49OS	-1	0.602	0.477
50OD	-3.75	>1	0.875
50OS	-4.5	>1	0.875
51OD	-1	0.477	-0.0969
51OS	-1.25	0.699	0.398
52OD	-2	>1	>1.301
52OS	-2	>1	1.301
53OD	0.25	0.176	0
53OS	0.375	0.176	0
54OD	-3	>1	1.176
54OS	-3	>1	1
55OD	-5	>1	1.301
55OS	-5.375	>1	>1.301
56OD	-2.625	>1	1.176
56OS	-2.75	>1	1.176
57OD	-3	>1	1.301
57OS	-3	>1	1.301
58OD	-5	>1	1.176
58OS	-4.875	>1	1.176
59OD	-1.25	0.176	0.176
59OS	-1.5	0.477	0.301

Subject Distribution

Total eyes:

High Hyperopes (>5)	0
Moderate Hyperopes (2-4.75)	0
Low Hyperopes (0.5-1.75)	8
Emmetropes	21
Low Myopes (0.5-1.75)	11
Moderate Myopes (1.875-4.75)	55
High Myopes (>5)	25

Statistical analysis:

Low Hyperopes (0.5-1.75)	2
Emmetropes	8
Low Myopes (0.5-1.75)	11
Moderate Myopes (1.875-4.75)	21

General Trend:

Low Hyperopes (0.5-1.75)	2
Emmetropes	1
Low Myopes (0.5-1.75)	9
Moderate Myopes (1.875-4.75)	28
High Myopes (>5)	1

LogMar conversions

20/10	-0.693	MAR=log 10 (D/Va)
20/15	-0.288	
20/20	0.000	
20/25	0.097	
20/30	0.176	
20/40	0.301	
20/50	0.398	
20/60	0.477	
20/70	0.544	
20/80	0.602	
20/100	0.699	
20/150	0.875	
20/200	1.000	
20/300	1.176	
20/400	1.301	

Picture Chart

20/200	tulip
20/100	duck, dog
20/80	fish, tulip
20/60	duck, dog, tulip, fish
20/40	tulip, fish, duck, dog
20/30	fish, tulip, dog, duck

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CONSENT TO PARTICIPATE IN RESEARCH

You are being asked to participate in research on the validity of a visual acuity chart. You will be shown two sets of distance visual acuity charts, you will be asked to report what letters or pictures that you see. Only your age, refractive status (eye glass prescription), and visual acuity measurements (size of objects you see without glasses) will be involved in the study. It will take approximately two minutes to complete these measurements. You will not be identified by name; all data will be confidential and reported only as a group. Your privacy will be protected to the maximum extent allowable by law. You will receive no compensation or special consideration for your participation. Your participation in this study is voluntary. If you have any questions regarding this study you may contact Michael Cron at (231) 591-2171. By signing below you give consent to participate in this research.

_____

Print Name

_____

Signature (parent if minor)

_____

Date

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Acuity Chart Project

Subject # _____

Name _____ Date _____

Age _____

Refraction:

OD _____ SE _____

OS _____ SE _____

Testing Order =

_____ Silhouette OD
_____ Silhouette OS
_____ Snellen OD
_____ Snellen OS

Silhouette Picture Unaided

OD 20/_____

OS 20/_____

Snellen Unaided

OD 20/_____

OS 20/_____