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A comparison of some near cross cylinder targets with variation of illumination

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A comparison of some near cross cylinder targets with variation of illumination

Abstract

The purpose of this thesis is to compare the results of different cross cylinder targets as shown below to the standard cross cylinder target used at Pacific University, and also to discover if a variation in illumination on one of the cross cylinder targets will have any effects on the results.

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A COMPARISON OF SOME
NEAR CROSS CYLINDER TARGETS WITH
VARIATION OF ILLUMINATION

A thesis presented to
the College of Optometry
Pacific University

By

Roy K. Hirokawa

Robert Pinder

May, 1963

APPARATUS:

Phoropter

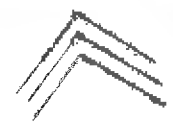
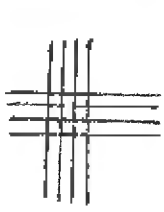
Standard Cross Grid target

Chevron Cross Grid target

Variable Color Cross Grid Target

PURPOSE:

The purpose of this thesis is to compare the results of different cross cylinder targets as shown below to the standard cross cylinder target used at Pacific University, and also to discover if a variation in illumination on one of the cross cylinder targets will have any effects on the results.



PROCEDURE:

Each subject's name and age were recorded. The interpupillary distance measurements were taken to align the phoropter properly. Next, a near cylinder check was taken to neutralize any existing astigmatism. The amount of cylinder found in each patient was placed in the phoropter preceding the near cross cylinder tests.

Step 1. To determine the amount of near cylinder a cross grid of 90 and 180 degrees was placed at 16 inches. The subject is previously placed at the blur out - recovery point at near monocularly. He is asked which lines are darkest- horizontal or vertical. If the horizontal and vertical lines appear to have the same darkness to him, then absence of any astigmatism is assumed. But if one set of lines appear darker, minus cylinder is inserted, axis 90 from the darkest line until both sets of lines appear to have the same darkness. The oblique cross grid is then presented and the subject is asked which set of lines is darkest - up and to the right or up and to the left. The cylinder axis is turned until the opposite set of lines are darkest. The cylinder is rocked back and forth until a definite reversal range is determined. The midpoint of the range is taken as the cylinder axis and the power is then rechecked in the usual manner.

Step 2. With the amount of cylinder in place, the illumination is dimmed to the recommended level of approximately $\frac{1}{4}$ foot

candles , or the overhead lamp facing the wall in the refracting room at Pacific U. clinic. Plus is added, approximately to the 20/30 Snellen acuity level which was previously determined. The cross cylinder was placed in the position with the axis at 90. The subject is asked " which set of lines are darkest". When it is confirmed that the vertical lines are darker using the alternate occlusion method, plus is reduced in .25 diopter steps until a neutrality is reached. If neutrality is impossible, the recorded reading is the last vertical response before a reversal occurs.

Still under the reduced illumination, an associate phoria is taken with the gross findings in place. Following the alternate occlusion method a binocular cross cylinder finding is taken with the aniso of the #14A. The latter is taken from the minus side (increasing plus) until a neutrality is obtained. Using a reduced Snellen chart with illumination increased to normal, the binocular cross cylinder phoria is taken.

Step 3. The procedure is the same as step 2 except that a chevron card is used instead of the cross grid card. Also when #14A is taken the cross cylinders are placed at axes 135 and when the #14B is taken the cross cylinders are placed at axes 45.

Step 4. Same as Step 3 except that the room is illuminated with 10 foot candles with the overhanging light half way between the wall and the card.

Step 5. Same as Step 3 except that the room is illuminated

with 20 foot candles with the overhanging light $\frac{2}{3}$ of the way between the wall and the card.

Step 6. Same as Step 2 except that the Variable color card is used instead of the standard cross grid. The illumination is the same as those of the cross grid illumination.

TABLE A

Chevron Card Stand. Illum.		Chevron Card 10' Candles		Chevron Card 20' Candles		Chevron Card 10' Candles		Chevron Card 20' Candles		
O.D.	O.S.	O.D.	O.S.	O.D.	O.S.	O.D.	O.S.	O.D.	O.S.	
Subj. 1										
14A	.50	.50	.25	.25	-.25	-.25	.25	Pl.	-.25	-.50
14B	.25	.25	Pl.	Pl.	-.25	-.25	Pl.	-.25	-.25	-.50
15A	<u>6xo</u>		<u>3xo</u>				<u>9</u>			
15B	4xo		3xo				2xo			
Subj. 2										
14A	1.25	1.25	.75	.75	-.50	-.50	1.00	1.00	-.25	-.25
14B	.75	.75	.50	.50	-.25	-.25	.50	.50	-.25	-.25
15A	<u>5xo</u>		<u>4xo</u>				<u>3xo</u>			
15B	3xo		2.5xo				1xo			
Subj. 3										
14A	.75	.75	.50	1.00	-.25	.25	.50	.50	-.25	-.25
14B	.25	.25	-.50	Pl.	-.75	-.25	Pl.	Pl.	-.25	-.25
15A	<u>6xo</u>		<u>4xo</u>				<u>4xo</u>			
15B	5xo		2xo				2xo			
Subj. 4										
14A	1.50	1.50	1.25	1.25	.25	.25	1.25	1.25	.25	.25
14B	.25	.25	.50	.50	.25	.25	.75	.75	.50	.50
15A	<u>21xo</u>		<u>20xo</u>				<u>20xo</u>			
15B	16xo		19xo				19xo			
Subj. 5										
14A	-1.25	-1.25	-1.50	-1.00	-.25	-.25	-.75	-.25	-.50	-.50
14B	-1.75	-1.75	-1.75	-1.25	0	.50	-1.50	-1.00	.25	.75
15A	<u>11xo</u>		<u>8xo</u>				<u>5xo</u>			
15B	7xo		6xo				6xo			
Subj. 6										
14A	1.25	1.75	.75	.75	-.50	-1.00	.75	1.00	.50	.75
14B	1.00	1.50	.50	.50	-.50	-1.00	.75	1.00	.25	.50
15A	<u>2xo</u>		<u>2xo</u>				<u>2xo</u>			
15B	9		8xo				3xo			
Subj. 7										
14A	1.00	1.50	.75	1.25	-.25	-.75	.50	1.00	-.50	-.50
14B	.50	1.00	.25	.75	-.25	-.25	Pl.	.50	-.50	-.50
15A	<u>5xo</u>		<u>6xo</u>				<u>5xo</u>			
15B	5xo		3xo				2xo			
Subj. 8										
14A	1.00	.75	.50	.50	-.50	-.25	.50	.50	-.50	-.25
14B	.50	.25	.25	.25	-.25	0	.25	.25	-.25	0
15A	<u>9xo</u>		<u>10xo</u>				<u>8xo</u>			
15B	6xo		6xo				4xo			

TABLE A (cont.)

Chevron Card Stand. Illum.		Chevron Card 10' Candles		Chevron Card 20' Candles						
O.D.	O.S.	O.D.	O.S.	40.D.	40.S.	O.D.	O.S.	40.D.	40.S.	
Subj. 9										
14A	-1.50	+1.50	+0.75	-1.25	-0.75	-0.25	+0.25	-0.75	-1.25	-0.75
14B	+0.75	+0.75	P1	+0.50	-0.75	-0.25	+0.25	+0.25	-1.00	-0.50
15A	<u>7xo</u>		<u>11xo</u>				<u>7xo</u>			
15B	<u>5xo</u>		<u>3xo</u>				<u>4xo</u>			
Subj. 10										
14A	1.25	+1.75	+1.50	+1.75	-0.25	0	-1.25	-2.00	0	+0.25
14B	1.00	+1.50	+0.75	+1.00	-0.25	-0.50	+0.25	1.00	-0.75	-0.50
15A	<u>6xo</u>		<u>7xo</u>				<u>8xo</u>			
15B	<u>6xo</u>		<u>3xo</u>				<u>1xo</u>			
Subj. 11										
14A	-0.75	-0.25	-0.75	-1.00	0	-0.75	-1.25	-1.50	-0.50	-1.25
14B	-1.25	-0.75	-1.25	-1.50	0	-0.75	-1.75	-2.00	-0.50	-1.25
15A	<u>9xo</u>		<u>9xo</u>				<u>5xo</u>			
15B	<u>7xo</u>		<u>5xo</u>				<u>3xo</u>			
Subj. 12										
14A	+1.00	+1.25	+0.75	+3.00	-0.25	-0.25	+0.50	+1.00	-0.50	-0.25
14B	+0.50	+0.75	P1	+0.25	-0.50	-0.50	-0.50	P1	-1.00	-0.75
15A	<u>12xo</u>		<u>10xo</u>				<u>7xo</u>			
15B	<u>5xo</u>		<u>4xo</u>				<u>2xo</u>			
Subj. 13										
14A	P1	-0.25	1.25	P1	+0.25	+0.25	+0.25	P1	-0.25	+0.25
14B	-0.50	-0.75	-0.50	-0.75	0	0	-0.25	-0.50	+0.25	+0.25
15A	<u>5xo</u>		<u>5xo</u>				<u>5xo</u>			
15B	<u>3xo</u>		<u>3xo</u>				<u>4xo</u>			
Subj. 14										
14A	1.25	+1.00	+0.75	+0.75	-0.50	-0.25	1.00	+1.00	-0.25	0
14B	+0.75	+0.50	+0.50	+0.50	-0.25	0	P1	P1	-0.75	-0.50
15A	<u>8xo</u>		<u>8xo</u>				<u>6xo</u>			
15B	<u>6xo</u>		<u>5xo</u>				<u>3xo</u>			
Subj. 15										
14A	-0.50	-0.50	-1.25	-1.25	-0.75	-0.75	-2.75	-3.50	-2.25	-3.00
14B	-1.00	-1.00	-2.50	-2.50	-1.50	-1.50	-2.50	-3.25	-1.50	-2.25
15A	<u>3xo</u>		<u>2xo</u>				<u>1so</u>			
15B	<u>3xo</u>		<u>3xo</u>				<u>1so</u>			
Subj. 16										
14A	1.25	1.50	0.50	0.50	-0.75	-1.00	P1	P1	-1.25	-1.50
14B	+0.50	+0.75	P1	P1	-0.50	-0.75	-0.25	-0.25	+0.75	-1.00
15A	<u>10xo</u>		<u>12xo</u>				<u>8xo</u>			
15B	<u>9xo</u>		<u>10xo</u>				<u>8xo</u>			
Subj. 17										
14A	1.50	1.50	1.25	1.25	-0.25	-0.25	1.00	1.00	-0.50	-0.50
14B	1.25	1.25	0.50	0.50	-0.75	-0.75	0.25	0.25	-1.00	-1.00
15A	<u>3xo</u>		<u>1so</u>				<u>2xo</u>			
15B	<u>2xo</u>		<u>2so</u>				<u>1xo</u>			

Table A (cont.)

Chevron Card Standard Illum.		Chevron Card 10' Candles				Chevron Card 20' Candles				
O.D.	O.S.	O.D.	O.S.	O.S.	O.S.	O.D.	O.S.	O.D.	O.S.	
Subj. 18										
14A	1.50	1.50	1.75	1.75	+.25	+.25	1.50	1.50	0	0
14B	+.50	+.50	1.00	1.00	+.50	+.50	+.75	+.75	+.25	+.25
15A	<u>21xo</u>		<u>18xo</u>				<u>19xo</u>			
15B	18xo		16xo				18xo			
Subj. 19										
14A	1.00	1.25	1.25	1.25	+.25	0	1.75	1.75	+.75	+.50
14B	+.25	+.50	± P1	P1	-.25	-.50	+.75	+.75	+.50	+.25
15A	<u>6xo</u>		<u>4xo</u>				<u>4xo</u>			
15B	5xo		6				3xo			
Subj. 20										
14A	1.00	1.25	1.25	1.25	+.25	0	+.25	+.75	-.75	-.50
14B	+.75	1.00	-.25	-.25	-1.00	-1.25	-.50	P1	-1.25	-1.00
15A	<u>10xo</u>		<u>14xo</u>				<u>12xo</u>			
15B	11xo		6xo				6xo			
Subj. 21										
14A	2.50	2.50	2.25	2.00	-.25	-.50	1.25	1.25	-1.25	-1.25
14B	2.25	2.25	1.50	1.25	-.75	-1.00	1.00	1.00	-1.25	-1.25
15A	<u>10xo</u>		<u>11xo</u>				<u>8xo</u>			
15B	8xo		7xo				2xo			

TABLE B

Standard Cross Grid		Chevron Card Stand. Illum.				Variable Color Card				
O.D.	O.S.	O.D.	O.S.	O.D.	O.S.	O.D.	O.S.	O.D.	O.S.	
Subj. 1										
14A	+ .75	+ .50	+ .50	- .25	0	+ .50	P1	- .25	- .50	
14B	+ .50	+ .25	+ .25	- .25	0	P1	- .50	+ .50	- .75	
15A	<u>11xo</u>	<u>6xo</u>	<u>6xo</u>	<u>5xo</u>		<u>1xo</u>		<u>12</u>		
15B	<u>6xo</u>	<u>4xo</u>	<u>4xo</u>	<u>2xo</u>		<u>1xo</u>		<u>5xo</u>		
Subj. 2										
14A	+1.50	+1.50	+1.25	+1.25	- .25	- .25	+1.00	-1.00	- .50	+ .50
14B	+1.00	+1.00	+ .75	+ .75	- .25	- .25	+ .50	- .50	- .50	+ .50
15A	<u>6xo</u>	<u>6xo</u>	<u>5xo</u>			<u>1.5xo</u>				
15B	<u>4xo</u>	<u>4xo</u>	<u>2xo</u>			<u>4xo</u>				
Subj. 3										
14A	+1.25	+1.25	+ .75	+ .75	- .50	- .50	-1.00	+1.00	- .25	- .25
14B	+ .50	+ .50	+ .25	+ .25	- .25	- .25	- .25	- .25	- .75	- .75
15A	<u>11xo</u>	<u>6xo</u>	<u>6xo</u>			<u>4xo</u>				
15B	<u>6xo</u>	<u>6xo</u>	<u>5xo</u>			<u>1xo</u>				
Subj. 4										
14A	+1.75	+1.25	+1.50	+1.50	- .25	+ .25	+1.75	-1.75	0	+ .50
14B	+ .50	P1	+ .25	+ .25	- .25	+ .25	+ .25	+ .25	- .25	+ .25
15A	<u>20xo</u>		<u>21xo</u>			<u>22xo</u>				
15B	<u>20xo</u>		<u>16xo</u>			<u>17xo</u>				
Subj. 5										
14A	- .25	P1	-1.25	-1.25	-1.00	-1.25	-1.50	-1.00	-1.25	-1.00
14B	- .75	- .50	-1.75	-1.75	-1.00	-1.25	-2.25	-1.75	-1.50	-1.25
15A	<u>15xo</u>		<u>11xo</u>			<u>10xo</u>				
15B	<u>8xo</u>		<u>7xo</u>			<u>8xo</u>				
Subj. 6										
14A	+1.25	+2.25	+1.25	+1.75	0	- .50	+1.25	+1.75	0	- .50
14B	+1.00	2.00	+1.00	+1.50	0	- .50	+1.50	+1.50	0	- .50
15A	<u>10xo</u>		<u>2xo</u>			<u>0</u>				
15B	<u>2xo</u>		<u>0</u>			<u>1xo</u>				
Subj. 7										
14A	+1.25	+1.50	+1.00	+1.50	- .25	0	+ .25	+ .75	-1.00	- .75
14B	+ .75	+1.00	+ .50	+1.00	- .25	0	P1	+ .50	- .75	- .50
15A	<u>10xo</u>		<u>5xo</u>			<u>0</u>				
15B	<u>7xo</u>		<u>5xo</u>			<u>4xo</u>				
Subj. 8										
14A	+1.00	+ .50	+1.00	+ .75	0	+ .25	+ .50	+ .50	- .50	0
14B	+ .50	P1	+ .50	+ .25	0	+ .25	P1	P1	- .50	0
15A	<u>11xo</u>		<u>9xo</u>			<u>10xo</u>				
15B	<u>7xo</u>		<u>6xo</u>			<u>6xo</u>				
Subj. 9										
14A	+2.00	+1.75	+1.50	+1.50	- .50	- .25	+2.00	+2.00	0	+ .25
14B	+1.00	+ .75	+ .75	+ .75	- .25	P1	+1.25	+1.25	+ .25	+ .50
15A	<u>14xo</u>		<u>7xo</u>			<u>9xo</u>				
15B	<u>6xo</u>		<u>5xo</u>			<u>6xo</u>				

TABLE B (cont.)

Standard Cross Grid		Chevron Card Stand. Illum.				Variable Color Card				
O.D.	O.S.	O.D.	O.S.	O.D.	O.S.	O.D.	O.S.	O.D.	O.S.	
Subj. 10										
14A	1.25	2.50	1.25	-1.75	0	-.75	-1.75	+2.25	.50	-.25
14B	-.75	1.50	1.00	-1.50	+.25	P1	+1.00	+1.50	.25	0
15A	<u>11xo</u>		<u>6xo</u>				<u>7xo</u>			
15B	<u>6xo</u>		<u>6xo</u>				<u>7xo</u>			
Subj. 11										
14A	-.75	-.25	-.75	-.25	0	0	-1.50	-1.00	-.75	-.75
14B	-1.00	-.50	-1.25	-.75	-.25	-.25	-2.00	-1.50	-1.00	-1.00
15A	<u>8xo</u>		<u>9xo</u>				<u>5xo</u>			
15B	<u>7xo</u>		<u>7xo</u>				<u>3xo</u>			
Subj. 12										
14A	1.00	+1.50	1.00	-1.25	0	-.25	+1.25	-1.50	+.25	0
14B	-.75	+1.25	.50	-.75	-.25	-.50	-.50	.75	-.25	-.50
15A	<u>8xo</u>		<u>12xo</u>				<u>10xo</u>			
15B	<u>10xo</u>		<u>6xo</u>				<u>8xo</u>			
Subj. 13										
14A	1.25	+.75	P1	-.25	-1.25	-1.00	P1	-.25	-1.25	-1.00
14B	.50	P1	-.50	-.75	-1.00	-.75	-1.50	-1.75	+2.00	-1.75
15A	<u>10xo</u>		<u>5xo</u>				<u>4xo</u>			
15B	<u>8xo</u>		<u>3xo</u>				<u>1xo</u>			
Subj. 14										
14A	1.25	+1.25	-1.25	1.00	0	-.25	-1.00	+1.00	-.25	-.25
14B	-.75	-.75	.75	.50	0	-.25	.50	+.50	-.25	-.25
15A	<u>10xo</u>		<u>8xo</u>				<u>7xo</u>			
15B	<u>8xo</u>		<u>6xo</u>				<u>4xo</u>			
Subj. 15										
14A	+.50	-.75	-.50	-.50	-1.00	-1.25	-.75	-1.25	-1.25	-2.00
14B	-.50	-.75	-1.00	-1.00	-.50	-.25	-.75	-1.25	-.25	-.50
15A	<u>4xo</u>		<u>2xo</u>				<u>5xo</u>			
15B	<u>3xo</u>		<u>3xo</u>				<u>2xo</u>			
Subj. 16										
14A	1.25	1.50	1.25	1.50	0	0	+.50	+.75	-.75	-.75
14B	1.00	1.25	.50	.75	-.50	-.50	+.25	.50	-.75	-.75
15A	<u>12xo</u>		<u>11xo</u>				<u>6xo</u>			
15B	<u>10xo</u>		<u>9xo</u>				<u>7xo</u>			
Subj. 17										
14A	2.00	2.00	1.50	1.50	-.50	-.50	1.00	1.00	-1.00	-1.00
14B	1.25	1.25	1.25	1.25	0	0	.75	.75	+.50	-.50
15A	0		<u>3xo</u>				<u>2xo</u>			
15B	<u>2xo</u>		<u>2xo</u>				<u>1xo</u>			
Subj. 18										
14A	1.50	1.50	+1.50	1.50	0	0	+1.50	1.50	0	0
14B	1.25	1.25	.50	.50	-.75	-.75	.75	.75	-.50	-.50
15A	<u>21xo</u>		<u>21xo</u>				<u>18xo</u>			
15B	<u>22xo</u>		<u>18xo</u>				<u>17xo</u>			

TABLE B (cont.)

Standard Cross Grid		Chevron Card Stand. Illum.				Variable Color Card				
O.D.	O.S.	O.D.	O.S.	∠O.D.	∠O.S.	O.D.	O.S.	∠O.D.	∠O.S.	
Subj. 19										
14A	1.50	+1.50	+1.00	+1.25	-.50	-.25	+1.25	+1.00	-.25	-.50
14B	1.00	+1.00	+.25	+.50	-.75	-.50	+.25	+ P1	-.75	-1.00
15A	<u>8xo</u>		<u>6xo</u>				<u>6xo</u>			
15B	6xo		5xo				4xo			
Subj. 20										
14A	1.75	+1.75	+1.00	+1.25	-.75	-.50	+1.25	+1.25	-.50	-.50
14B	1.25	+1.25	+.75	+1.00	-.50	-.25	+.75	+.75	-.50	-.50
15A	<u>14xo</u>		<u>10xo</u>				<u>11xo</u>			
15B	14xo		11xo				11xo			
Subj. 21										
14A	1.75	+1.75	+2.50	+2.50	+.75	+.75	+2.00	+1.75	+.25	P1
14B	1.50	+1.50	+2.25	+2.25	+.75	+.75	+1.00	+.75	-.50	-.75
15A	<u>7xo</u>		<u>10xo</u>				<u>9xo</u>			
15B	5xo		8xo				6xo			

TABLE 1

Frequency distribution of #14A O.D. for Chevron card under standard illumination and Chevron card under 10' candles of illumination.

Let +.05 D = 1 then +.25 D = 5 -.25 = -5

Change in Diopters	Conversion	f	X'	fX'	fX' ²
-.75	-15 - 19	3	4	12	48
-.50	-10 - 14	4	3	12	36
-.25	-5 - 9	8	2	16	32
P1	0 - 4	1	1	1	1
+.25	+5 - 1	5	0	0	0

Σf = 21 ΣfX' = 41 ΣfX'² = 117

$\Sigma X^2 = (\Sigma + X^2) - \frac{(\Sigma X)^2}{N}$
 $\Sigma X^2 = [117 - \frac{41^2}{21}] = 27$
 $\Sigma X^2 = [117 - 80] = 37$
 $\Sigma X^2 = 37 \times .25^2$
 $\Sigma X^2 = 9.25$

$S^2 = \frac{\Sigma X^2}{N-1}$
 $S = \sqrt{\frac{9.25}{20}}$
 $S = 6.8$

10 Diopters = 6.8 x C
 = ± 34 D

Calculation of mean

-15
-10
-5
0
5
-25

$5 \sqrt{-25}$

$-5 \times .05 = -.25 D$ (mean)

Therefore the mean difference between 14A under standard illumination and #14A under 10 ft. candles illumination is -.25 D with a standard deviation of ± .34 D.

TABLE 2

Frequency distribution of #14A Δ O.D. for Chevron card under standard illumination and Chevron card under 20' candles of illumination.

Let .05 D = 1

Change in Diopters	Conversion	f	X'	fX'	fX' ²
-2.25	-45 - 49	1	12	12	144
-2.00	-40 - 44	0	11	0	0
-1.75	-35 - 39	0	10	0	0
-1.50	-30 - 34	0	9	0	0
-1.25	-25 - 29	3	8	24	192
-1.00	-20 - 24	0	7	0	0
-.75	-15 - 19	1	6	6	36
-.50	-10 - 14	6	5	30	150
-.25	-5 - 9	5	4	20	90
+ P1	0 - 4	2	3	6	18
+.25	+ 5 - 1	1	2	2	4
+.50	+10 - 6	1	1	1	1
+.75	+15 - 11	1	0	0	0

$\Sigma f = 21$ $\Sigma fX' = 101$ $\Sigma fX'^2 = 636$

$\Sigma X' = 101$
 $\Sigma X'^2 = 636$
 $\Sigma X'^3 = 476$
 $\Sigma X'^4 = 3371$

$S^2 = \frac{636}{21} - \left(\frac{101}{21}\right)^2$
 $S = 1.77$
 $S = 1.77$

$S \text{ in Diopters} = 1.77 \times .05$
 $= .885$
 $\approx \pm .75 D$

Calculation of mean

-45
-40
-35
-30
-25
-20
-15
-10
-5
0
5
10
15
-195

$13 \times -15 = -195$
 $-15 \times .05 D = -.75 D$
 (mean)

Therefore the mean difference between 14A under standard illumination and #14A under 20' candles illumination is $-.75 D$ with a standard deviation of $\pm .75 D$.

TABLE III

Frequency distribution of #14B = 0.D. for Chevron card and chevron card under 10' ft candle illumination.

Let $+0.05D = 1$

Change in Diopters	Conversion	f	X'	fX'	fX' ²
-1.50	-35 - 39	1	8	8	64
-1.25	-30 - 34	0	7	0	0
-1.00	-25 - 29	1	6	6	36
-.75	-20 - 24	4	5	20	100
-.50	-15 - 19	3	4	12	48
-.25	-10 - 14	7	3	21	63
pl	- 5 - 9	3	2	6	12
+.25	+ 0 - (-4)	1	1	1	1
+.50	+ 5 - 4	1	0	0	0
		21	74	324	

Calculation of mean

-35
-30
-25
-15
-10
- 5
0
+ 5
+10
<hr/>
-105

Mean difference between 14B under standard illumination and 14B under 10 ft candles of illumination is $-.58D$ and standard deviation is $\pm .44D$

TABLE IV

Frequency distribution of 14B 20.D. Chevron card under standard illumination and Chevron card under 20' candle illumination.

Let $+0.5D = 1$

Change in Diopters	Conversion	f	X'	fX'	fX' ²
-1.50	-30 = 34	1	8	8	64
-1.25	-25 = 29	2	7	14	98
-1.00	-20 = 24	3	6	18	108
-.75	-15 = 19	2	5	10	50
-.50	-10 = 14	3	4	12	48
-.25	-5 = 9	6	3	18	108
0	0 = 0	0	2	0	0
+.25	+5 = 1	3	1	3	3
+.50	+10 = 6	1		0	0
		21		83	479

$\Sigma X' = 53$
 $\Sigma fX' = 83$
 $\Sigma fX'^2 = 479$
 $\Sigma X'^2 = 21$
 $\Sigma X' = 35.25$

$S = \frac{35.25}{21}$
 $S = 1.68$
 $S = 13.28$
 $S = 2.6$

Calculation of mean

-30
-25
+20
-15
-10
-5
0
+5
+10
-90

$\frac{-10}{1-50} = -10 \times 0.5 = -50$

Mean difference between 14B under standard illumination and 14B and 20' candles using the Chevron card is $-0.50D$ with standard deviation of $\pm 0.66D$

TABLE 5

Frequency distribution of #14A Δ O.D. for Chevron card under standard illumination and Standard Cross grid under standard illumination.

Let .05 D = 1

Change in Diopters	Conversion	f	X'	fX'	fX' ²
-1.25	-25 - 29	1	8	8	64
-1.00	-20 - 24	1	7	7	49
-.75	-15 - 19	1	6	6	36
-.50	-10 - 14	4	5	20	100
-.25	-5 - 9	5	4	20	90
P1	0 - 4	8	3	24	72
.25	5 - 1	0	2	0	0
.50	10 - 6	0	1	0	0
.75	15 - 11	1	0	0	0
		<u>21</u>		<u>75</u>	<u>411</u>

Calculation of mean:

-25
-20
-15
-10
-5
0
5
10
15
<u>-45</u>

$9 \times -45 = -405$
 $-5 \times .05 = -.25$

Therefore the mean difference between #14A under standard illumination and the #14A using the Chevron card with standard illumination is -.25 D and the standard deviation is 1 .69 Diopters.

TABLE VI

Frequency distribution of 14A ΔO.D. between Standard Cross Grid and variable color card.

Let .05D = 1

Change in Diopters	Conversion	f	X'	fX'	fX' ²
-1.25	-25 - 29	3	7	21	147
-1.00	-20 - 24	2	6	12	72
-.75	-15 - 19	2	5	10	50
-.50	-10 - 14	3	4	12	48
-.25	-5 - 9	4	3	12	36
pl	0 - 4	4	2	8	16
+.25	+5 + 1	2	1	2	2
+.50	+10 + 6	1	0	0	0

$\Sigma X' = 75$
 $\Sigma fX' = 75$
 $\Sigma fX'^2 = 371$
 $\bar{X} = \frac{\Sigma X'}{n} = \frac{75}{21} = 3.57$
 $s^2 = \frac{\Sigma fX'^2 - \frac{(\Sigma fX')^2}{n}}{n-1} = \frac{371 - \frac{75^2}{21}}{20} = \frac{371 - 265.71}{20} = \frac{105.29}{20} = 5.26$
 $s = \sqrt{5.26} = 2.29$

Calculation of mean

-25
-20
-15
-10
-5
0
+5
+10
<hr/>
-60

$\bar{X} = \frac{-75}{21} = -3.57$
 $s = \sqrt{5.26} = 2.29$

Mean difference for 14A is -0.375 and the Standard Deviation is ± 0.5675 for Standard Cross Grid and Variable Color Card.

TABLE VII

Frequency distribution of 14B Δ D.D. for Chevron card and standard cross grid.

Let .05D = 1 for conversion

Change in Diopters	Conversion	f	X'	fX'	fX' ²
-1.00	-20 - 24	2	7	14	98
- .75	-15 - 19	2	6	12	72
- .50	-10 - 14	3	5	15	45
- .25	- 5 - 9	8	4	32	128
0	0 - 4	4	3	12	36
+ .25	+ 5 + 4	1	2	2	4
+ .50	+10 + 6	0	1	0	0
+ .75	+15 + 11	1	0	0	0

$$\Sigma X' = \left[\Sigma fX' - \frac{(\Sigma fX')^2}{n} \right]^{1/2}$$

87 383

$$s^2 = \frac{575}{20}$$

$$\Sigma X'^2 = \left[383 - \frac{7567}{20} \right]^{1/2}$$

$$s = \sqrt{\frac{575}{20}}$$

$$\Sigma X' = \left[383 - 360 \right]^{1/2}$$

$$s = 5.36$$

$$\Sigma X'^2 = 575$$

$$s \text{ in diopters} = 2680$$

Calculation of mean

-20
-15
-10
- 5
0
+ 5
+10
+15
-20

$$8 \sqrt{-20}$$

$$-2.5 \times .05 = -.125$$

Mean is -.125 for distribution of 14B Δ D.D. for Chevron card and standard cross grid, the Standard Deviation is $\pm .2680$.

TABLE VIII

Frequency distribution of 14B Δ O.D. for Standard Cross Grid and variable color card.

Let .05D = 1 for conversion

Change in Diopters	Conversion	f	X'	fX'	fX' ²
-2.00	-40 = 44	1	10	10	100
-1.75	-35 = 39	0	9	0	0
-1.50	-30 = 34	0	8	0	0
-1.25	-25 = 29	0	7	0	0
-1.00	-20 = 24	1	6	6	36
-.75	-15 = 19	4	5	20	100
-.50	-10 = 14	7	4	28	196
-.25	-5 = 9	4	3	12	36
0	0 = 4	1	2	2	4
+.25	+5 = 1	2	1	2	2
+.50	+10 = 9	1	0	0	0

$$\sum X' = [21] = 21$$

$$\sum X'^2 = [474] = 474$$

$$\sum fX' = [80] = 80$$

$$\sum fX'^2 = [4225] = 4225$$

$$S = \sqrt{\frac{4225}{20}} = 14.52$$

$$S = \sqrt{\frac{474 - \frac{80^2}{20}}{20}} = 14.52$$

Calculation of mean

40
-35
-30
-25
-20
-15
-10
-5
0
+5
+15
<hr/>
165

$$11 \sqrt{-165} = -15 \times .05 = -.75$$

Mean difference is $-.75$ for 14B Δ O.D. between Standard Cross Grid and variable color card.

DISCUSSION

This thesis attempts to show the difference in the results obtained from twenty-one different subjects on testing with the Standard Exam Grid, the Chevron Card and Variable Color Card. Also the Chevron Card results were obtained under Standard illumination, 10 ft. candle illumination and 20 ft. candle illumination.

A comparison is made on the basis of the dioptric difference obtained from data on the twenty-one subjects. Table A shows the change in diopters of #14A and #14B between Chevron Card under standard illumination and Chevron Card under 10 ft. and 20 ft. candle illumination. Table B shows the change in diopters of #14A and #14B between the Standard Gross Grid the Chevron card and the Variable Color Card.

From these table it is seen that the aniso change from O.D. to O.S. is practically the same in all tests therefore all calculations are made using only the O.D.

Table's #1 through #8 show a frequency distribution of the dioptric difference obtained on the twenty-one different subjects. From these tables a standard deviation and mean is calculated using the conversion factor of .05 diopters equal to 1. Therefore $+.25 D$ is equal to 5 and $-.25 D$ is equal to -5. The formula for standard deviation were obtained from Allen L. Edward's text of Statistical Analysis.

The phoria data is included but no calculations have been done for the change in phoria in this thesis.

CONCLUSION

From this thesis it can be concluded that when #14A and #14B are taken with high illumination as compared to #14A and #14B with standard illumination there is a definite sign of more minus in the mean dioptric difference. When the #14A and #14B are taken using the Variable Color card the mean dioptric difference showed more minus than when the Chevron card was used. Both of these cards were compared to the Standard Cross Grid.

The selected group for this thesis were made up of all oriental and Hawaiian students which were all non-observers for these different tests. We were not able to make any direct relationship in this thesis because of the race or nationality.