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Evaluation of a modified application procedure of glare reducing skin coatings as utilized in athletics

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Second Advisor

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EVALUATION OF A MODIFIED APPLICATION PROCEDURE OF GLARE REDUCING SKIN COATINGS AS UTILIZED IN ATHLETICS

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SIGNATURE PAGE

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ABSTRACT

Traditionally, athletes who have applied glare reducing skin coatings have applied it as a black stripe on the cheek bone directly under the eyes. This substance was found to enhance contrast sensitivity when applied in the normal manner in an investigation by Dayton, Elm, Houle, Thomas, Reichow, and Roth. This paper will address the ability of the Cramer glare reducing skin coating to further increase contrast sensitivity utilizing a modified application technique. Utilizing the Arden Plates, contrast sensitivity (CS) was measured on 60 subjects ages 15-30 in a high glare environment using three methods; without the product, with the glare reducing product applied the traditional way, and with the product applied in a more arcuate manner. With the intense glare source on, subjects' CS increased significantly at all spatial frequencies tested when wearing the SGB in the modified manner. At .35 and 1.4 cpd, significant improvement was noted when comparing no *Sun Glare Black* (SGB) and the modified application technique. At .7 cpd, significant improvement was shown when comparing no SGB and SGB applied in the modified fashion, and when comparing traditional and modified techniques. At 2.8 cpd, a significant improvement was revealed between no SGB and SGB applied traditionally, and when comparing no SGB and the modified application technique.

INTRODUCTION

For many years, athletes have been applying a black substance under their eyes for the purpose of minimizing glare so as to enhance visual performance. The application has traditionally been a horizontal streak immediately below the eyes. However, to our knowledge, variations in the application procedure have never been tested.

Coffey and Reichow discovered that elite-level athletes had better overall CS performance than non-athletes.[1] Dayton, Elm, Houle, Thomas, Reichow, and Roth investigated the effects of a glare reducing substance on CS; and found a significant increase in CS at the spatial frequency of .8 cpd.[2] If CS is a factor in athletics, and if glare reducing skin coatings increase CS, then perhaps a modification in the application of the coating may further increase CS, and consequently enhance athletic performance.

This paper will investigate the effect of a modified application technique of *Sun Glare Black* on CS in a high glare environment. This product is commercially available from Cramer Products, Inc.

METHODS

PHOTOMETRIC ANALYSIS

The product utilized in this project was *Sun Glare Black* (SGB), Type B, by Cramer Products, Inc. Dayton et. al. determined this substance to have the lowest Gloss Index (GI) of three types tested.[2] A definition of Gloss Index and results of the photometric testing performed by Dayton et. al. are given in Figure 1.

SUBJECTS, METHODS, AND MATERIALS

The 60 subjects of this study (ages 15 - 30) were required to have binocular distance acuities, unaided or with contact lenses, of 20/25 or better. Spectacle correction was not permitted.

Contrast Sensitivity (CS), utilizing the Arden Plates in a high glare environment, was tested under three conditions: with SGB, without SGB, and with SGB applied in a more arcuate manner around the eyes (Figure 3). The order of the test conditions was randomly assigned for each subject to rule out any practice effect.

The glare source was a circular array of lights on a reflective (aluminum foil) background (Figure 2). The top edge of the Arden Plate viewing pocket was placed in the center of the array, which was approximately 90 cm. in diameter. The test distance was one

meter, the top of the viewing pocket was 118 cm. above the floor, and the subject's lateral canthus was positioned at 127 cm. above the floor. Three variable transformers controlled the light sources, which consisted of twelve blue photoflood lamps (see Figure 2 legend). The test room was dark except for the light emitted from the glare source array. Photometry readings were taken just prior to and immediately following subject testing. Initial illuminance at the plane of the subjects' eyes was 1500 lux. The illuminance following subject testing was 1470 lux, a negligible 2% decline. Luminance values were measured with a telephotometer focused just above the lip of the pocket while each plate was exposed at the #8 scale reading. Readings were: Plate #2 - 64 nits; Plate #3 - 98 nits; Plate #4 - 62 nits; and Plate #5 - 63 nits.

Arden Plates #2, #3, #4, and #5 were presented at one meter. This test distance was necessary to accommodate the lighting arrangement used. The resulting spatial frequencies were .35, .7, 1.4, and 2.8 cycles per degree, respectively. The test plates were presented in a fixed random order (either 3-5-2-4, 4-2-5-3, or 5-3-4-2). A metronome with an audible "tick" was used to monitor plate presentation at the desired rate of one increment per second. To avoid bias, the experimenter presenting the plates was not aware of the subjects' testing condition.

SUBJECT TESTING

Upon arrival at the test site, subjects read and signed the informed consent form (Appendix 2), and Experimenter #1 then took binocular distance Snellen acuities. At this point, SGB was either traditionally applied, applied in a more arcuate manner, or the subject began testing without SGB.

Experimenter #2 escorted the subject into the testing room and aligned his/her lateral canthi for the correct test height (127 cm). The subject's gaze was directed to the top edge of the pocket from which the plates were pulled (118 cm - slightly below eye level as recommended in the Arden Plate instruction set). Next, the subject listened to a pre-recorded instruction set (Appendix 3) while Experimenter #2 demonstrated the procedure. Contrast sensitivity was then tested using the four Arden Plates (one at a time) being presented at a rate of one increment per second by Experimenter #3.

The subject then left the room and Experimenter #1 changed the test condition by removing the SGB, applying the SGB, or changing the SGB application procedure as needed. The test sequence described above was then repeated; however, the instruction set was

not replayed. Upon completion, the subject left the room and Experimenter #1 changed to the remaining test condition, as described above. The test sequence was then repeated a third time without the instruction set.

Upon completion of testing, subjects were asked to respond to the question, "Was a difference noted when comparing the three testing conditions? If so, please describe."

RESULTS

PHOTOMETRIC ANALYSIS

Sun Glare Black (SGB), Cramer B, was the only glare reducing skin coating used in this project. Dayton et.al., had already determined this to be the most effective commercially available substance at that time. It had the lowest Gloss Index of the three glare reducing skin coatings compared in their study.

SUBJECT DATA

The Arden Plates were analyzed individually. Within each Arden Plate analysis, we compared the results of SGB applied traditionally versus without, SGB applied in a modified fashion versus without, and the modified versus traditional application techniques.

Plate #5 (2.8 cpd) data displayed a significant improvement with SGB applied traditionally versus without ($p=.006 \times 3 = .018$, adjusted for multiple t-tests). Mean improvement was .95 increments. The range with SGB applied traditionally was 7 to 18, and the range without SGB was 6 to 20. A significant improvement was also displayed with SGB applied in a modified fashion versus without (adjusted $p=.002$).

Mean improvement was 1.6 increments. The range with SGB applied in a modified fashion was 5 to 18. There was no significant improvement in comparing the traditional and modified applications of SGB (adjusted p=.18).

Plate #3 (.7 cpd) data showed no significant improvement with SGB applied in a traditional fashion versus without (adjusted p=1.00). A significant improvement was noted when comparing SGB applied in the modified fashion versus without (adjusted p=.027). Mean improvement was .7 increments. The range without SGB was 9 to 16, and 6 to 15 with the modified application. Comparing the modified application versus the traditional, a significant improvement was shown with the modified application technique (adjusted p=.03). Mean improvement was .6 increments. The range was 6 to 17 with SGB applied traditionally, and 6 to 15 with the modified application.

Plate #4 (1.4 cpd) data displayed no significant improvement with the traditional application versus without (adjusted p=.397). A significant improvement was shown with the modified application versus without (adjusted p=.0006). Mean improvement was 1.1 increments. The range of the modified application was 4 to 16, and 4 to 18 without SGB. Comparing the traditional versus modified

showed no significant improvement (adjusted p=.085).

Plate #2 (.35 cpd) data showed no significant improvement with the traditional application versus without (adjusted p=.14). A significant improvement was noted with the modified application versus without (adjusted p=.03). Mean improvement was .8 increments. The range of the modified application was 6 to 19, and without SGB was 6 to 20. There was no significant improvement with the traditional application versus the modified technique (adjusted p=1.00).

Of the 60 subjects tested (regardless of subjective response), when comparing no SGB to the standard application, 61.7% showed improvement, 36.7% showed decreased performance, and 1.7% showed no change.

In the standard and modified application comparison, 63.3% showed improvement, 33.3 showed decreased performance, and 3.3% showed no change.

When comparing no SGB to the modified technique, 65% showed increased performance, 28.3% showed decreased performance, and 6.6% showed no change. Again, these changes are based on the subject's average score under the three testing conditions.

"Was a difference noted when comparing the three testing

conditions? If so please describe." In response to this question, 66.7% reported improvement when comparing the standard application of SGB to no SGB. Of these, 62.5% actually showed improvement based on their average score with and without SGB. 35% had decreased performance, and 2.5% showed no change. Of NO or SAME responders, 60% showed improvement, while 40% showed decreased performance.

When comparing the standard and modified application techniques, 51.7% reported improvement with the modified procedure. 80.7% of YES responders actually showed improved performance, 16.1% had decreased performance, and 3.2% showed no change. 58.6% of NO or SAME responders actually showed improvement, while 34.5% showed decreased performance, and 3.5% stayed the same.

Finally, when comparing no SGB and the modified application, 78.3% reported improvement with the modified technique. Of these, 70.2% showed improved performance, 23.4% showed decreased performance, and 6.4% showed no change. Of NO or SAME responders, 46.2% actually showed improvement, while 46.2% showed decreased performance, and 7.7% showed no change.

Discussion

We tested Arden Plate contrast sensitivity under three conditions in a high glare environment. The glare source was positioned in a circular array around the test plates. This set-up was utilized in order to simulate intense glare conditions as often encountered in athletics. It was desired to have glare emitted from all directions relative to the subject's pupil, rather than from a single direction. While the use of a glare reducing skin coating may increase constrast sensitivity and, thereby, enhance athletic performance, utilizing the skin coating in the modified application technique discussed in this paper may further improve CS and, consequently, athletic performance.

Our data indicates that, compared with the traditional application, the modified application of SGB increased CS significantly at one of the four spatial frequencies tested (.7 cpd). At all four spatial frequencies tested, the modified application significantly improved CS as compared to no SGB. At one of the four spatial frequencies tested (2.8 cpd), significant improvement was noted when comparing traditional versus without.

Suggestions for future testing include: (1) having the glare source array in a smaller circle around the test plates, (2) modifying

the instructions for the subjective response so as to specify whether the subject is to compare glare or contrast sensitivity, (3) utilizing a mask with the SGB already applied so the subject is unaware of which application technique is being tested, (4) investigating the effects of the modified application on peripheral vision, (5) giving multiple presentations of each plate under each glare condition, and (6) testing CS using higher spatial frequencies.

REFERENCES

1. Coffey B., Reichow AW. Athletes vs. Non-athletes: Static Visual Acuity, Contrast Sensitivity, Dynamic Visual Acuity (abstract). Invest Ophthalmol Vis Sci 1989; 30(Suppl):517.

2. Dayton D., Elm J., Houle M., Thomas D, Reichow AW, Roth N. Evaluation of Glare Reducing Skin Coatings as Utilized in Athletics. Pacific University College of Optometry Thesis, May, 1990.

GLOSS INDEX (GI) DEFINED

GLOSS CAN BE VIEWED AS A FUNCTION OF THE RATIO OF THE AMOUNT OF LIGHT EMITTED (L_A) ALONG A PERPENDICULAR, TO THE AMOUNT EMITTED (L_B) AT THE ANGLE OF RELFECTION WHEN A SURFACE IS OBLIQUELY ILLUMINATED (FIG. 1).

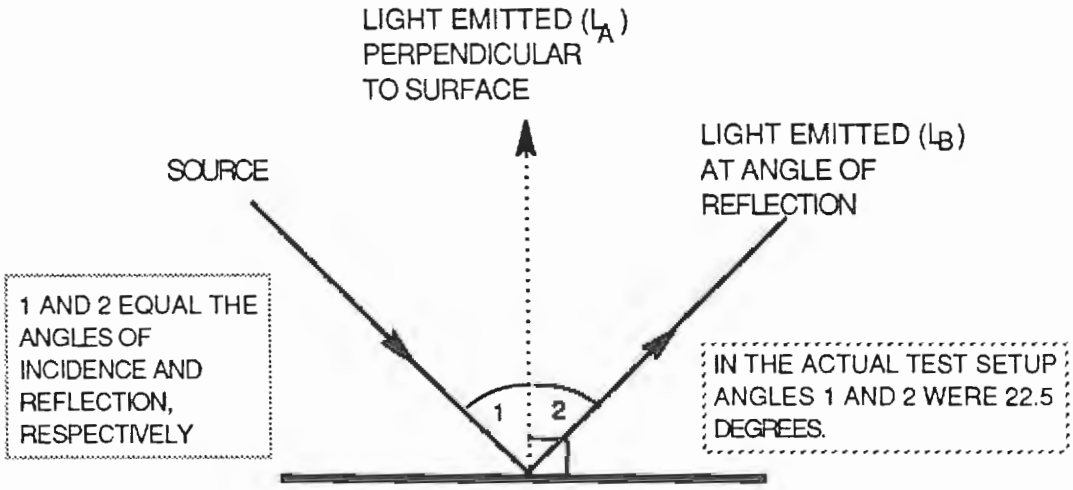


FIG. 1

THUS, IF GLOSS IS DEFINED AS 1 - (L_A/L_B), A PERFECTLY SHINY SURFACE, FOR EXAMPLE A MIRROR, HAS A GLOSS INDEX = 1 - (0/L_B) = 1.0, BECAUSE L_A = ZERO. ON THE OTHER HAND, A PERFECT DIFFUSER (REGARDLESS OF REFLECTANCE) HAS GI = 1 - (L_A/L_B) = ZERO, BECAUSE $L_A = L_B$.

SO, FOR THE THREE TYPES OF COATINGS,

	L_A	L_B	GI	
CRAMER A	37	133	0.95	WORST
CRAMER B	39	52	0.25	BEST
MUELLER	69	140	0.51	IN BETWEEN

REFERENCE SURFACES CONSISTING OF CARBON BLACK AND BARIUM SULPHATE (WHITE STANDARD) WERE ALSO TESTED TO VALIDATE THE PROCEDURE. DESPITE THE MARKED DIFFERENCE BETWEEN THEIR REFLECTANCES, 0.025 VERSUS 0.99, RESPECTIVELY, EACH YIELDED A GLOSS INDEX VALUE INDISTINGUISHABLE FROM ZERO.

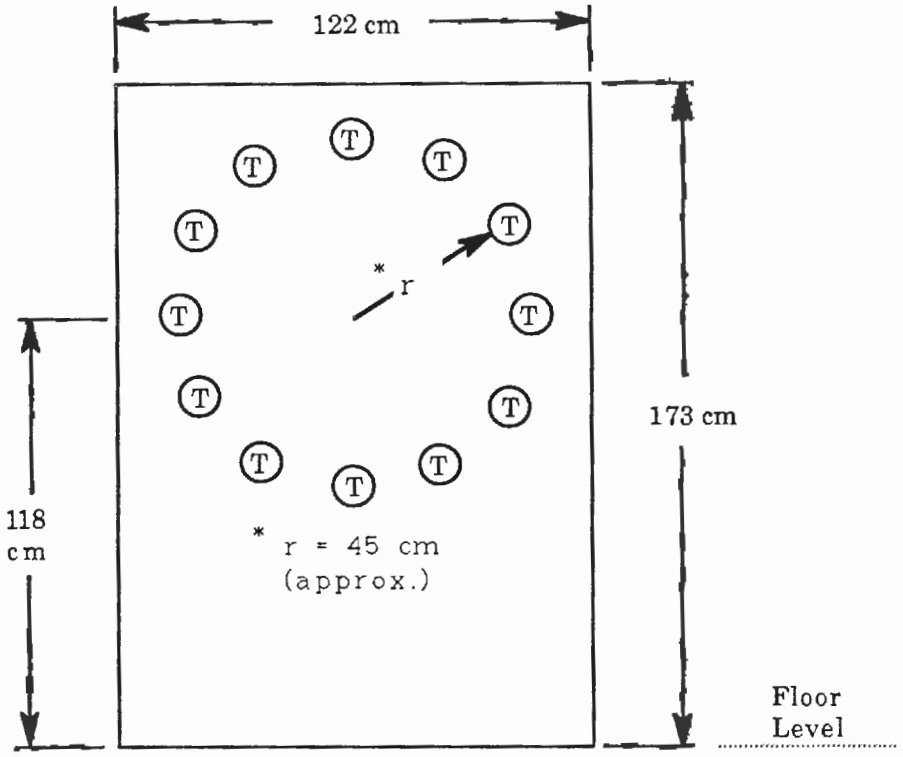
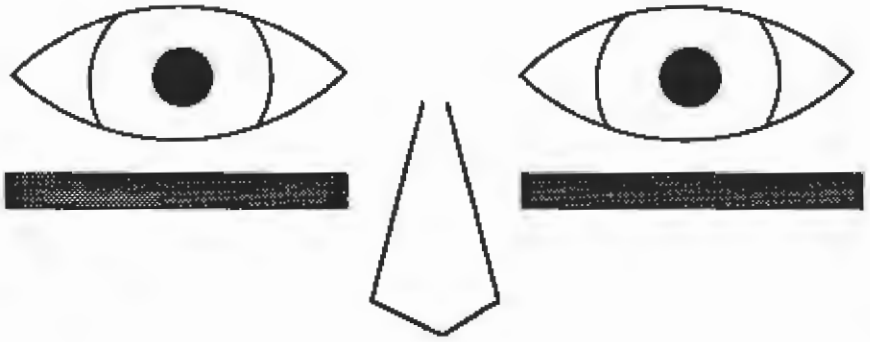


Fig. 2. Glare source apparatus.
Source array consists of 12 blue photoflood tungsten lamps (T) rated at 250 watts, 115 volts. Actual operating voltage was about 70% of maximum due to limitations in current capacity of supply lines. See text for additional details.

A.



B.

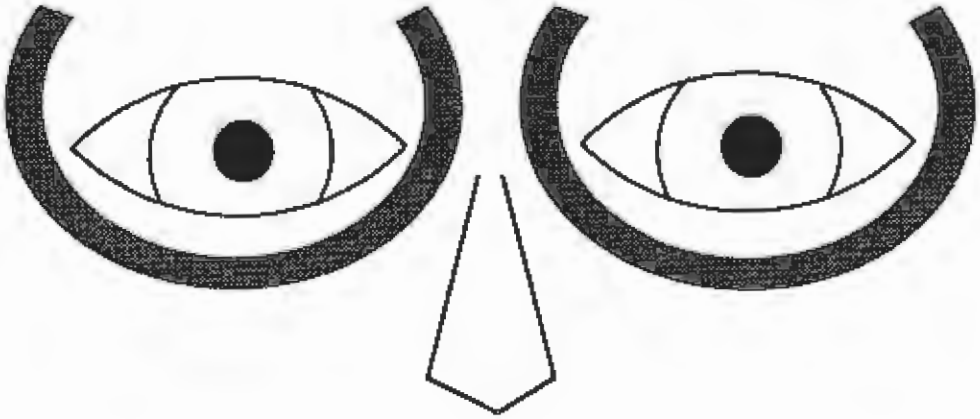


FIG. 3. The traditional (A), and modified (B) applications of Sun Glare Black.

APPENDIX 1

IRB Submission

I. Project title

Evaluation of a Modified Application Procedure of Glare Reducing Skin Coatings as Utilized in Athletics

II. Abstract

Many athletes, especially baseball and football players, wear a black grease paint or similar product on their cheek area apparently to reduce glare and enhance visual performance. Research conducted at Pacific University from 1989-1990 supported this theory. Our research will attempt to determine whether or not a modified application procedure of glare reducing skin coatings significantly reduces the stray light entering the pupil versus the standard application procedure. We will also determine if this use increases effective visibility.

We would like to determine if, in fact, this type of application is more beneficial for athletes, and if so, would it be beneficial in other situations where stray light creates a problem.

III. Location of project

The project will take place at Pacific University College of Optometry.

IV. Project overview

Human subjects testing for enhanced visual performance from use of the glare reducing product will utilize contrast sensitivity as measured with the Arden Plates. Subjects will be tested through their habitual Rx under glare conditions. They will be tested three times; once with SUN GLARE BLACK on the cheek area as directed on the product label, once with the product applied in a more arcuate manner around the eye, and once without the product. We will utilize flood lamps providing approximately 10,000 lux as our standardized light level during the contrast sensitivity testing. The lights will be calibrated and rechecked at one third intervals throughout testing to maintain consistency.

Subjects will be required to have minimum Snellen visual acuities of 20/25 in each eye. No spectacle correction will be allowed during testing. Contact lenses will be allowed and will be noted for possible further analysis. Actual contrast sensitivity will be tested binocularly. Population age range will be 15 to 30. Subjects will be randomly assigned to start testing under one of the three test conditions, and then retested under the remaining two conditions.

APPENDIX 1 cont.

V. Risks

This type of product is used routinely by athletes and there are no apparent risks. The manufacturer gives two cautions: (1) may stain some fabrics, and (2) avoid contact with eyes.

VI. Procedures to avoid risks

The product will be applied no closer than one quarter inch from the lid margins. The experimenters will apply and remove the product. Subject's cheek and nose area will be wiped clean with an alcohol wipe before testing and again following removal of the product. Patients will be instructed to close their eyes during application, removal, and cleaning. Experimenters will keep saline available for washing debris from any affected eyes. A list of ingredients will be provided. Subjects who are allergic to any of the ingredients will not be allowed to participate.

VII. Dates of Project and Signatures

Subject testing will be run between June 1, 1990 and December 1, 1990.

Dr. Niles Roth.....

Dr. Alan W. Reichow.....

Gary White.....

Jeff Tack.....

Ryan Nielsen.....

APPENDIX 2

Informed Consent Form

1. Institution

A. Title of Project.....	**Evaluation of A Modified Application Procedure of Glare Reducing Skin Coatings as Utilized In Athletics**	
B. Principal Investigators.....	Gary White	357-2198
	Jeff Tack	357-2933
	Ryan Nielsen	357-2933
C. Advisors.....	Dr. Reichow	357-6151 ext. 2283
	Dr. Roth	357-6151 ext. 2271
D. Location.....	Pacific University Forest Grove, OR 97116	
E. Date.....	June, 1990	

2. Description of Project

This project is designed to test the effects of a glare reducing, black, grease paint on visual performance when applied to the cheek area below the eyes. Testing will be done under glare conditions similar to those experienced in athletic competition. We will apply and remove the product (SUN GLARE BLACK by Cramer Products, Inc.) Please do not touch the product as this could affect our measurements. We suggest that you wash with soap and water following the product's removal. Your vision will be tested under three conditions: with SUN GLARE BLACK on the cheek area, without it, and with it applied in a more arcuate manner around the eye.

3. Description of Risks

This type of product is used routinely by athletes and there are no obvious risks. The manufacturer lists two cautions: (1) may stain some fabrics (2) avoid contact with eyes. We will take all necessary precautions to prevent any problems. The product will not be applied closer than one quarter inch from the eye area. Saline is available to wash the eyes if accidental debris occurs. The ingredients of the product are: petrolatum, talc, mineral oil, amber wax, stearic acid, lanolin, iron oxides, and lecithin. If you are allergic to any of these please withdraw from the project.

4. Benefits

If you participate in sports or recreational activities which involve glare, the results of this project may suggest that you consider utilizing this product to aid in performance.

5. Compensation and Medical Care

If you are injured in this experiment it is possible that you will not receive compensation or medical care from Pacific University, the experimenters, or any organization associated with the experiment. All reasonable care will be used to prevent injury however.

APPENDIX 2 cont.

6. Offer to Answer any Inquiries

The experimenters will be happy to answer any questions that you may have at any time concerning this project. If you are not satisfied with the answers you recieve, please call Dr. James Peterson at 357-0442. During your participation in the project you are not a clinic patient for the purposes of the research and all questions should be directed to the researchers and/or the faculty advisors who will be solely responsible for any treatment (except an emergency.)

7. Freedom to Withdraw

You are free to withdraw your consent and to discontinue participation in this project or activity at any time without prejudice to you.

I have read and understand the previous page. I am 18 years of age or over (or I am having this form signed by a parent or guardian).

Printed Name.....

Signed..... Date.....

Address..... Phone.....

City, State, Zip.....

APPENDIX 3

This chart will be used to demonstrate contrast sensitivity. The test will begin with a blank plate that will look like this. The plate will slowly be raised. You will be scanning the plate looking for the point where you can first detect the difference in shade of lines, like here. There will be four plates each of which will have different widths of lines and spaces. They can be wider or narrower than seen here. They will be oriented vertically like this.