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Drew Dayton

Pacific University

James Elm

Pacific University

Mike Houle

Pacific University

David Thomas

Pacific University

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Evaluation of glare reducing skin coatings as utilized in athletics

Abstract

For many years, athletes have been wearing a black substance under their eyes. The ability of this substance to enhance an athlete's performance has never been tested. This paper will address the ability of this substance to increase contrast sensitivity. Three different glare reducing skin coatings were photometrically tested to determine the product with the lowest gloss index. Utilizing the Arden Plates, contrast sensitivity (CS) was measured on 55 subjects ages 22-40 in a high glare environment both with and without the most effective glare reducing product. When wearing the glare reducing skin coating, subject's CS increased significantly at the spatial frequency of 0.8 cpd, under our test conditions.

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Committee Chair

Alan W. Reichow

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EVALUATION OF GLARE REDUCING
SKIN COATINGS AS UTILIZED IN ATHLETICS

By

DREW DAYTON

JAMES ELM

MIKE HOULE

DAVID THOMAS 1962-

Richard

A thesis submitted to the faculty of the
College of Optometry
Pacific University
Forest Grove, Oregon
for the degree of
Doctor of Optometry
May, 1990

Advisors:

Alan W. Reichow, OD
Niles Roth, OD

SIGNATURE PAGE

EVALUATION OF GLARE REDUCING SKIN COATINGS
AS UTILIZED IN ATHLETICS

By

Drew Dayton..... *Drew Dayton*

James Elm..... *James L. Elm*

Mike Houle..... *Mike Houle*

David Thomas..... *David Thomas*

Advisors

Alan W. Reichow, OD..... *Alan W. Reichow*

Niles Roth, OD..... *Niles Roth*

ACKNOWLEDGEMENTS

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ABSTRACT

For many years, athletes have been wearing a black substance under their eyes. The ability of this substance to enhance an athlete's performance has never been tested. This paper will address the ability of this substance to increase contrast sensitivity. Three different glare reducing skin coatings were photometrically tested to determine the product with the lowest gloss index. Utilizing the Arden Plates, contrast sensitivity (CS) was measured on 55 subjects ages 22-40 in a high glare environment both with and without the most effective glare reducing product. When wearing the glare reducing skin coating, subject's CS increased significantly at the spatial frequency of 0.8 cpd, under our test conditions.

INTRODUCTION

For many years, athletes have been wearing a black substance under their eyes to supposedly reduce glare and enhance visual performance. Apparently, the purpose is to reduce the amount of light reflected off the cheek toward the pupil, thereby improving athletic performance when glare is a factor. However, to our knowledge, its effect on vision has never been shown.^{a,b}

Ginsburg and Evans, found that pilots' contrast sensitivity (CS) predicted their ability to detect a small, semi-isolated air-to-ground target during flight simulation under their test conditions.¹ Coffey and Reichow found that athletes had better overall CS performance than nonathletes.² These studies seem to indicate that improved CS could enhance human performance. If glare reducing skin coatings increase CS, they may enhance athletic performance as well.

This paper will address the ability of *Sun Glare Black*, a commercially available product by Cramer Products, Inc., to enable increased CS in a high glare environment.

METHODS

PHOTOMETRIC ANALYSIS

Prior to subject testing, we photometrically determined the Gloss Index for three glare-reducing skin coatings. The three products tested were: *No Glare* by Mueller Sports Medicine, Inc.; *Sun Glare Black* by Cramer Products, Inc.; and an earlier type *Sun Glare Black* by Cramer Products, Inc. which has a shinier appearance than the newer product. A definition of Gloss Index (GI) and results of the

photometric testing are given in Figure 1. The newer type of *Sun Glare Black* (SGB) had the lowest GI (0.25) making it the product of choice for subject testing.

POPULATION AND SET-UP

The population consisted of 55 subjects age 22-40. Subjects were required to have monocular visual acuities of 20/25 or better, unaided or with contact lenses. Spectacle correction was not permitted. Contrast sensitivity (CS) was tested with the Arden Plates in a high glare environment, under two conditions: with SGB and without SGB. The order of testing was randomly assigned for each subject to rule out any practice effect.

Our glare source was a bank of lights within a reflective background (Figure 2). The glare source frame's top edge was positioned 10 inches below the top edge of the Arden Plate viewing pocket, and was angled 45 degrees. This caused light incident on the cheek area to be reflected toward the pupil. Three variable transformers controlled the light source, each was set at 105 volts. The test room was dark except for light emitted from the glare source. Photometry readings were taken just prior to testing and repeated following completion of subject testing. Initial illuminance at the plane of the subject's eyes was 3690 lux. The illuminance following subject testing was 3340 lux (9.5% drop, probably due to lamp aging). Luminance values were measured with a tele-photometer focused on increment #2 while the plate was exposed to level #6. Initial readings were: Plate #2 - 95 nits; Plate #3 - 100 nits; Plate #4 - 95 nits; and Plate #6 - 94 nits.

Arden Plates #2, #3, #4, and #5 were presented at 114 cm. This is twice the standard distance for this test and was necessary to accommodate the lighting set up used. The resulting spatial frequencies were 0.4, 0.8, 1.6, and 3.2 cycles per degree, respectively. The test plates were presented in a "fixed-random" order (either 3-5-2-4 or 4-2-5-3) to avoid anticipation or practice effect. A clock with an audible "tick" was used to monitor plate presentation at the desired rate of one increment per second. To avoid bias, the experimenter who presented the plates and recorded the findings was not aware of the testing condition.

SUBJECT TESTING

Upon arrival at the test site, subjects read and signed the informed consent form (see Appendix 2). Experimenter #1 gave background information on contrast sensitivity (see Appendix 3) and took monocular visual acuities. At this point, either SGB was applied, or the subject began testing without SGB.

Experimenter #2 escorted the subject into the testing room and aligned his/her lateral canthi for correct test height (48"). The subject's gaze was directed to the top edge of the pocket from which the plates were pulled (44" height - slightly below eye level as recommended in the Arden Plate instruction set). Next, the subject listened to a recorded instruction set (see Appendix 4). Following CS testing by Experimenter #3, subjects were shown three rows of five Landolt rings with 20/25 demand at 114 cm. These were displayed under the same glare conditions as the Arden Plates. Subjects called out two rows of the rings. This was performed to assist participants in making subjective comparisons between test conditions.

The subject then left the test room and Experimenter #1 changed the test condition by either removing or applying the SGB as needed. The test sequence described above was then repeated, however, the instruction set was not replayed.

Subjects were asked to respond to this written question following testing: "Was a difference noted between testing conditions? If so, please describe."

RESULTS

PHOTOMETRIC ANALYSIS

Photometric analysis of the three glare reducing skin coatings gave the following results: Cramer A (the older type *Sun Glare Black*) had the worst Glare Index (GI=0.95). Cramer B (the newer *Sun Glare Black*) had the best score (GI=0.25). The Mueller *No Glare* had a value between those of the two Cramer products (GI=0.51). Reference surfaces consisting of carbon black and a barium sulphate test plate were also analyzed. Their Glare Index scores were no different from zero by the methods used here, thus validating the photometric analysis.

SUBJECT DATA

We analyzed the Arden Plates individually. Improvement was significant on one of the four plates tested.

Plate #3 (0.8 cpd) data displayed a significant improvement with SGB ($p=.0072 \times 4 = 0.03$, adjusted for multiple t-tests). Mean improvement was .595 increments, range with SGB 7 to 12.5, range without SGB 7 to 14.5. This p value implies a 97% probability that the improvement was due to the Sun Glare Black.

Plate #2 (0.4 cpd) data revealed no significant improvement (adjusted $p=.4332$.)

Plate #4 (1.6 cpd) data were likewise not significant ($p=.3528$.)

Plate #5 (3.2 cpd) data also showed no significant improvement (adjusted $p=0.16$.)

58.2% of the subjects reported improvement when queried, "Was a difference noted between testing conditions? If so, please describe." Of the YES responders, 62.5% actually showed improvement based on their average score with SGB compared to their average score without SGB. 34.4% had decreased performance, and 3.1% showed no change. Of the NO responders, 39.1% showed improvement, while 52.2% had decreased performance, and 8.7% showed no change. Of the 55 subjects tested (regardless of their subjective response) 29 (52.7%) showed improvement while wearing SGB, 23 (41.8%) showed decreased performance while wearing SGB, and three subjects (5.5%) showed no change. Again, these changes are based on the subject's average score with SGB compared to his/her average score without SGB.

DISCUSSION

We tested contrast sensitivity with the Arden Plates in a high glare environment. The glare source was positioned directly below the test plates, allowing light incident on the cheek area to be reflected toward the pupil.

This set-up may seem unusual, because we normally imagine the sun or artificial stadium lights as being overhead. However,

consider a fly ball in a baseball game. If the light source always remained higher (relative to the horizon) than the baseball, only a cap would be needed to shield the player's eyes from the light. This is not always the case. Frequently, especially late in the afternoon as the sun approaches the horizon, the ball will be higher, relative to the horizon, than the light source. Light incident on the cheek area may be reflected toward the pupil. Hypothetically, under these conditions, the athlete may benefit from use of a glare reducing skin coating.

Our data indicate that *Sun Glare Black* does enable increased CS at one particular spatial frequency (0.8 cpd). Additional testing is indicated to determine if enhancement is possible for other spatial frequencies and under other test conditions. Suggestions for future testing include: (1) multiple presentations of each plate under each test condition, (2) an automated presentation of the plates, (3) changing the light source intensity, (4) modifying light arrangements, (5) testing additional spatial frequencies, (6) using dynamic versus static targets, (7) CS testing by other means, and (8) applying the skin coatings in other patterns.

REFERENCES

1. Ginsburg AP, Evans DW, Sekule R, and Harp SA. Contrast sensitivity predicts pilot's performance in aircraft simulators. *Am J Optom Physiol Opt* 1982 Jan; 59(1):105-109.
2. 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.

FOOTNOTES

- a. Computerized literature search revealed no published reports related to this subject.
- b. Personal communication with Karen Terhune, chemist, in product development with Cramer Products, Inc., revealed that she was unaware of any controlled studies concerning effectiveness of glare-reducing skin coatings. Ms. Terhune helped develop the latest type of *Sun Glare Black* for Cramer.

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 REFLECTION WHEN A SURFACE IS OBLIQUELY ILLUMINATED (FIG. 1).

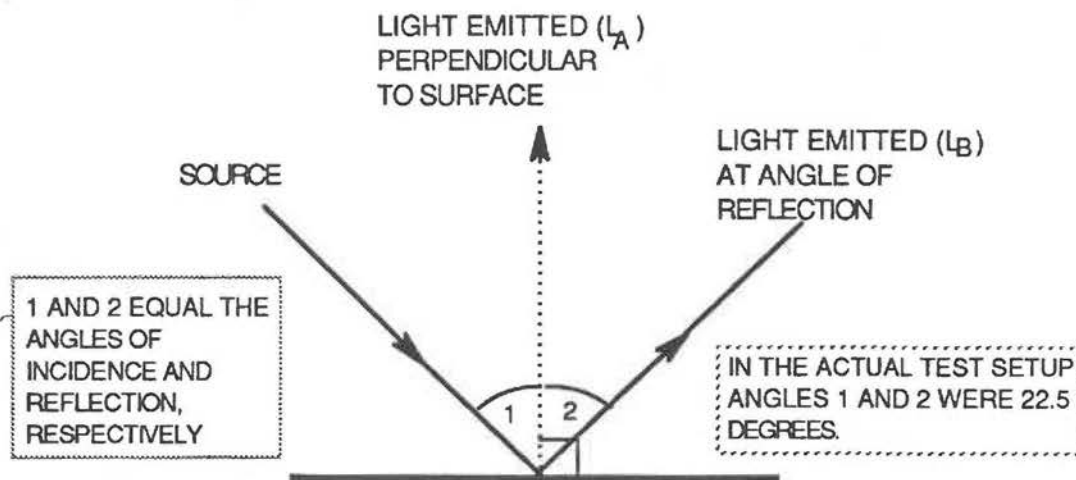


FIG. 1

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 $L_A = \text{ZERO}$. ON THE OTHER HAND, A PERFECT DIFFUSER (REGARDLESS OF REFLECTANCE) HAS $GI = 1 - (L_A/L_B) = \text{ZERO}$, BECAUSE $L_A = L_B$.

SO, FOR THE THREE TYPES OF COATINGS,

	LA	LB	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.

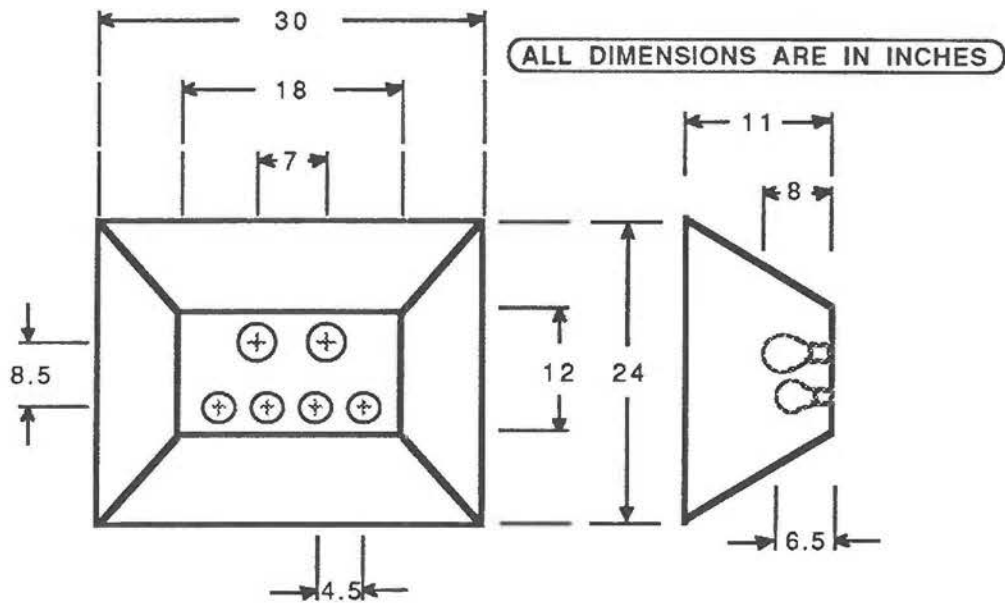


FIG. 2. Front and profile views of the glare source array consisting of two 500 watt and four 250 watt blue photoflood tungsten lamps. In order to avoid excessive decrement in outputs over the duration of the experiment, all lamps were operated at 105 volts (10 to 15 volts below their design rating). See text for additional data.

APPENDIX 1

IRB Submission

I. Project title

Evaluation 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. Our research will attempt to determine whether or not glare reducing skin coatings significantly reduce the stray light entering the pupil. Also, whether or not its use increases effective visibility.

We would like to determine if, in fact, this type of product is 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

To evaluate the glare reducing ability of the product (in this case, the Cramer Products, Inc. product, SUN GLARE BLACK) we will compare the reflective qualities of a bare template, the same template coated with carbon black, the template coated with SUN GLARE BLACK, and the template coated with other comparable products.

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 twice, once with, and once without SUN GLARE BLACK on the cheek area as directed on the product label. 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 20 to 40. Subjects will be randomly assigned to start testing with, or without glare reducing material in place, and then retested under the reverse condition.

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.

APPENDIX 1 cont.

VI. Procedures to avoid risks

The product will be applied no closer than one quarter inch from the lower lid margin. The experimenters will apply and remove the product. Subject's cheek area may 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 during fourth-year, spring, class block.

Dr. Alan W. Reichow.....
Dr. Niles Roth.....
Drew Dayton.....
Jim Elm.....
Mike Houle.....
Dave Thomas.....

APPENDIX 2

Informed Consent Form

1. Institution

- A. Title of Project..... Evaluation of Glare Reducing Skin Coatings as Utilized in Athletics
- B. Principal Investigators..... Drew Dayton 357-6040
Jim Elm 357-6040
Mike Houle 357-6040
Dave Thomas 357-6040
- C. Advisors..... Dr. Reichow 357-6151 ext.2283
Dr. Roth 357-6151 ext.2271
- D. Location..... Pacific University
Forest Grove, OR 97116
- E. Date..... January and February, 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 two conditions: with SUN GLARE BLACK and without it.

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.

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 receive, 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.

APPENDIX 2 cont.

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 (*Vistech*) will be used to demonstrate contrast sensitivity which will be tested inside. 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 than here, or smaller than here. They will be oriented vertically like here.

APPENDIX 4

We will be presenting you with four different contrast sensitivity demands. Each of these plates has a different width of light and dark variations as described to you earlier. Each one increases in contrast as you move down the plate. We will present these plates to you in random order, beginning initially with the demonstration plate. Notice on this demonstration plate that there are alternating dark and light spaces and that the contrast increases as you move down the plate.

We would like you to scan the top of the pocket as each plate is being pulled out and say “now” as soon as you notice the pattern. Remember to scan the top of the pocket rather than to fixate on a central location. The dark and light alternation exists on each of the test plates but is much more subtle than in the demo plate. Remember, respond as soon as you see the pattern. Approach the test with confidence, but try not to guess.

Upon completion of the four test plates we will present you with a chart of Landolt C’s. Each of these will be oriented with the opening of the C to the left, right, up, or down. Then, call out the orientation of the Landolt C’s as they appear to you, moving from left to right.

(Future experimenters may benefit by instructing subjects to “not look directly into the light source at any time.”)