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research article

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—**Benjamin R. Powers**

In the world of sports, especially at the professional level, athletes use every advantage they can to remain competitive. Glare from the sun or stadium lights can interfere with performance by reducing contrast between targets of interest and their background, for example, a ball moving through a crowded stadium. Methods to reduce this glare have been developed, and currently the most common is wearing eye-black grease or black adhesive strips (an alternative to the grease) under the eyes.

The first evidence of an athlete's use of a dark substance on the cheek is found in a 1942 photograph of Washington Redskins fullback Andy Farkas (1, as cited 2). In that era, players would burn cork and smear the ash on their cheeks. They thought that the dark pigment would absorb light, thereby preventing reflected light (glare) from interfering with their vision. Since then, ingredients have changed, but the concept lives on. There is even a waterproof form of eye black made for surfers called "Glareblox," though eye black is most commonly worn by baseball or football players (3). Today, eye black is very common and available at nearly every sporting goods store.

Recently, a different way of wearing eye black has emerged. Some players paint their entire faces, sometimes with elaborate designs, perhaps in an effort to intimidate their competition. In the professional leagues this can result in hefty fines, but players continue to do it. So why do athletes use eye black? Is it just a form of "war paint," or does it really give some visual advantage?

The only study to date testing the benefit of eye black was conducted in 2003 by DeBroff and Pahk (2). Eye-black grease and black adhesive strips were compared to clear petroleum jelly in their respective glare reducing abilities. Their study found that eye black improved participants' contrast sensitivity, though only slightly. Adhesive strips and clear petroleum jelly were not shown to be effective in reducing glare.

Although suggestive, the findings in that study may have been influenced by demand characteristics. That is, the participants in that study were aware of what was being tested: eye-black grease and strips versus petroleum jelly. Hence, they may have sensed a demand from the experimenter to behave in a way that supported what they believed to be the hypothesis of the study. This may have created a bias to perform better using one product than another.

Because DeBroff and Pahk found that only eye-black grease was beneficial, the present study tested only eye-black grease. The benefits of wearing eye black were examined under conditions that at least minimized, if not eliminated, demand characteristics. Specifically, participants were not aware of the difference between experimental and control conditions. For the control condition, a mock application that actually placed nothing on participants' cheeks was carried out.

Measuring Visual Performance

Introductory Psychology students from the University of New Hampshire were recruited. Tested were 18 men and 28 women between 18 and 33 years of age, whose vision was normal or corrected to normal (either by use of spectacles or contact lenses.)

The effects on vision of using eye black and no eye black were to be compared. For the former, a 2" x 3/4" stripe of Franklin brand eye black was applied across the participant's cheeks, centered 1/2" below each eye. For the control condition, or placebo, a Mattel brand toy lipstick applicator, of size and shape identical to the eye black applicator, gave a sensation equal to that of the eye-black application. However, the toy applicator actually placed nothing on the cheek. Half of the participants received the eye black first, and the other half received the placebo first. Participants were asked to close their eyes during application. This was done to reduce or eliminate the demand characteristics that may have affected the results of DeBroff and Pahk's study.

Participants sat in a chair and kept their heads in a fixed, upright position 1.15 meters from a Pelli-Robson contrast sensitivity chart (Fig. 1). This kind of chart is used by optometrists and ophthalmologists to measure individuals' ability to detect small differences in light contrast. After the first application, the first chart was presented. Two different versions of this chart were presented to each group in a random order but an equal number of times. This was done to prevent order effects on the scores of the participants. If one of the two charts should consistently produce a higher score, a random order of presentation would reduce the effect of this in the overall scores.

FIGURE 1 — Pelli-Robson chart. Sets of three letters, each set with different contrast. Contrast decreases with each set of three letters.

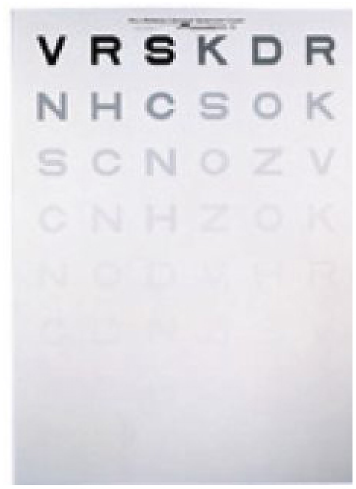

Figure 1

To keep trials as uniform as possible, participants then heard a set of instructions. Their task was to read the letters like a page in a book: line by line, left to right. On each line there were two groups of three dark letters on a white background. Each group had a different contrast, which decreased from left to right and from top to bottom. In accordance with the Pelli-Robson instructions, contrast threshold was defined as the last set of letters in which a participant could correctly identify at least two of the three. This letter set was recorded, along with the corresponding score, which is a measure of log contrast sensitivity. Log contrast sensitivity is the inverse of log contrast threshold. Contrast is defined as: C = L (ground) - L (letter)/L (ground) where C equals contrast, L (ground) represents the luminance of the background, and L (letter) represents the luminance of the letters.

When participants could read no further, trials were finished. Wet Ones brand face wipes were used to remove the substance while the participants closed their eyes, even if nothing had been applied. Used wipes were hidden so that even after the trial, there was no evidence of what had been used.

Trials were run from November 13, 2003 to February 25, 2004, outdoors between 1:00 and 2:00 P.M. This time of day provided the maximum light from the sun on the testing area. In the case of inclement weather when outdoor trials were not feasible, trials were run indoors in an identical format. Instead of natural light from the sun, a 100-watt bulb centered directly above the Pelli-Robson chart simulated the sun's position during the time of the outdoor trials.

Contrast Sensitivity Scores

Results of this study were analyzed using a repeated-measures t-test for the main effect: the use of eye black versus nothing at all. This test determines whether differences obtained are statistically significant as opposed to being due to chance alone. Also analyzed were the variables of eye color, sex, and testing site. Table 1 shows the results of the analysis. The column marked "t" is a statistic that shows the degree of difference between results of the experimental (eye black) and control condition, taking into account the variability of the results. The column marked "p" refers to the probability that the differences obtained were due to chance alone. By convention, statistically significant results are those that have a probability of less than five percent ($p < 0.05$) of being due to chance alone.

CONDITION	**EYE BLACK**	**CONTROL**	**t**	**p**
Overall	1.8489 (.1227)	1.7902 (.13192)	3.011	0.001*
Blue Eyes	1.8100 (.13256)	1.7900 (.15492)	0.695	0.499
Non-Blue Eyes	1.8677 (.11514)	1.7903 (.11208)	3.102	0.004*
Male	1.8083 (.12035)	1.7833 (.12485)	0.644	0.528
Female	1.8750 (.11902)	1.7946 (.13834)	4.091	0.0001*
Indoors	1.8923 (.10459)	1.8519 (.11957)	1.570	0.129
Outdoors	1.7925 (.12384)	1.7100 (.10208)	2.773	0.012*

TABLE 1 — Log contrast sensitivity means, t scores, and significance levels for the eye-black condition and the control condition (no eye black). Standard deviations are in parentheses. Asterisks indicate statistically significant effects.

The use of eye black significantly improved contrast sensitivity, though only by a small degree. The difference in means between the conditions of eye black and no eye black averaged only one step on the Pelli-Robson chart. Similarly small, yet statistically significant effects were found for the variables eye color, sex, and testing site. For participants with non-blue eyes, eye black provided a significant advantage in terms of contrast sensitivity. This was not the case for blue-eyed individuals. Participants tested outdoors showed a significant improvement in contrast sensitivity with eye black, whereas those tested indoors did not. Finally, women wearing eye black showed an improvement in contrast sensitivity relative to the control condition, while men did not.

Eye Black Shows Ability to Increase Visual Performance

The present study indicates that an individual wearing eye black scores significantly higher in contrast sensitivity than the same individual not wearing eye black. This is consistent with the findings of DeBroff and Pahk but improves upon their study by eliminating demand characteristics as a confounding variable.

There was a marked difference in the effect of eye black on those with blue versus non-blue eyes. This may be an example of the operation of Weber's Law of Just Noticeable Differences, or JNDs. This law states that for a change in intensity to be noticeable, the change must be proportional to the original intensity (4). In the case of glare arising from the cheek, its effect in reducing contrast is proportional to the existing level of ambient glare. Blue-eyed individuals, because they have less iris pigment to screen out unwanted light, have a greater level of intraocular scatter (light reflected within the eye) than non-blue-eyed people. Thus, for blue-eyed individuals, glare arising from the cheek should be less detectable than for individuals with darker irises. If glare is less detectable for the former, then eliminating or reducing it with eye black will have less of an effect than if the glare were more detectable, as is the case for non-blue-eyed people.

There was also a difference in the effect of eye black on those tested outdoors versus indoors. The artificial light source (100-watt bulb) used indoors was not as intense as the sunlight and, therefore, may not have produced as much cheek glare. Measurement of both light sources with a photometer showed that the average amount of glare during outdoor trials was as much as one hundred times the amount provided by the artificial light. The average scores of those tested indoors were significantly higher than those tested outdoors but showed no significant difference between the conditions of eye black and no eye black. This may be because the artificial glare was not sufficient in reducing contrast sensitivity to a level where the difference between the experiment and control conditions would become apparent. Because the amount of glare that participants experienced had an effect on their scores, a future study could attempt to test a range of light sources to find the exact glare threshold where eye black is effective. This would be useful information when comparing eye black effectiveness in games played under artificial light (stadium lights) and natural light.

Finally, the difference between men and women in the effectiveness of eye black might be due to the insufficient statistical power of the small sample size of males (18) versus females (28).

The present study indicates that wearing eye black can improve contrast sensitivity, presumably by reducing glare. This provides a potential advantage for those who participate in athletic activities. It remains to be seen, however, whether the small effect (one letter set of improvement in contrast sensitivity on a Pelli-Robson chart) translates to actual improvement in performance on the playing field.

This research was sponsored by Dr.Kenneth Fuld, chairman and professor of psychology at the University of New Hampshire. Dr Fuld was a key contributor to the formation of this thesis concept, provided criticism for editing and revision, and was a mentor to the author throughout the course of the research.

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Author Bio

Benjamin Powers graduated from the University of New Hampshire in May, 2004, with a BS in Psychology. It was partly his experience as captain of the UNH lacrosse team that motivated his study of the effectiveness of the eye black so widely used in the athletic world. Powers took issue with an existing study of eye black use because he saw in it two problems which he wanted to correct. He conducted his research with Professor Kenneth Fuld. Finding subjects and coordinating outdoor experiments with the weather sometimes proved difficult, but Powers and Fuld pushed hard to get a good final product, accomplishing their goal of getting into *print an amended study of the effectiveness of athlete's eye black. Powers has since entered the world of finance and is living on Beacon Hill in Boston.*

Mentor Bio

Kenneth Fuld is chair of the Department of Psychology and has been a professor at the University of New Hampshire for twenty-six years. His area of expertise is sensation and perception, primarily dealing with vision. He has mentored several undergraduate research projects during his tenure at UNH. Fuld advised all phases of this project, including a presentation at the department's annual Haslerud Research Conference. Watching his student grow intellectually and seeing the possibility of further research on this topic proved to be the most rewarding aspect for Professor Fuld. While he admits that there are always problems and unexpected complications with any research project, he points out, "That is part of the experience for students to gain. They see first-hand how difficult and time-consuming research is. I hope they also see how rewarding it can be."