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Contrast discrimination with Nike Maxsight contact lenses in natural light

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Abstract

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Methods: 33 subjects (14 male, 19 female) were placed in clear B&L Optima@ 38,50% VLT Amber Nike MAXSIGHTTM Contact Lenses and 36% VLT Grey-Green Nike MAXSIGHTTM contact lenses in an individualized randomized sequence. Subjects were dark-adapted with welding goggles prior to testing and in between sub-tests involving a Bailey-Lovie chart and the Haynes Distance Rock test. The sequence of testing was repeated for each lens modality.

Results: MAXSIGHTTM Amber and Grey-Green lenses enabled subjects to recover vision faster compared to clear lenses. Also, subjects were able to achieve better visual recognition in bright sunlight when compared to clear lenses. Additionally, the lenses allowed the subjects to alternate fixation between bright and shaded conditions at a more rapid rate as compared to clear lenses. Subjects preferred both MAXSIGHTTM Amber and Grey-Green lenses over clear lenses in the bright and shadowed conditions.

Conclusions: The results of the current study show that MAXSIGHTTM Amber and Grey-Green lenses provide better contrast discrimination in bright sunlight, better contrast discrimination when alternating between bright and shaded conditions, better speed of visual recovery in bright sunlight, and better overall visual performance in bright and shaded conditions.

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CONTRAST DISCRIMINATION WITH NIKE MAXSIGHT™ CONTACT LENSES IN NATURAL LIGHT

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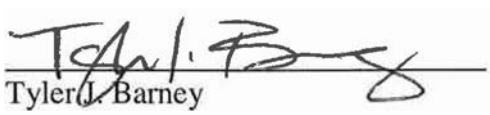

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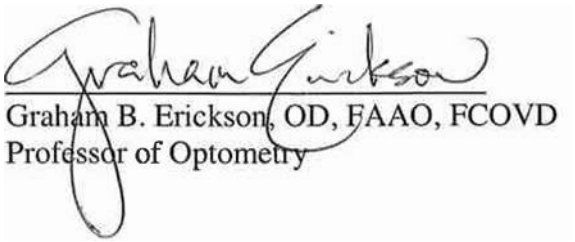

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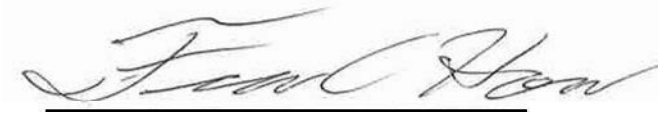

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Grade Page:

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Key Words: MAXSIGHT™, contact lens, contrast discrimination

Introduction

Contact lenses (CLs) are often the preferred mode of refractive correction for athletes. It has been reported that 95% of NCAA Division I-A athletes, 65% of Division III athletes, and 89% of professional athletes needing vision correction wear CLs.[1] Many athletes who compete in outdoor sports and require vision correction either wear prescription sunglasses or wear sunglasses over CLs. Some athletes choose not to wear any tinted eyewear due to frame discomfort, fit, or sports performance concerns. It is not surprising that Athletic Trainers-Certified (ATCs) at 63% of NCAA Division I-A, 86% of Division III, and 94% of professional teams have interest in tinted CLs for sports.[1]

Contact lenses with performance tints have been marketed for use in sports. The first tinted rigid gas permeable (RGP) CL was introduced in 1983,[2] although the tint provided no substantive protection from solar radiation. The first clear CLs with ultraviolet (UV) protection were made available in 1996.[2] The cornea is susceptible to damage from prolonged exposure to UV radiation between the wavelengths of 200 and 380 nm.[3] Additionally, studies have shown that short wavelength visible light, or blue light (380-500 nm)[4], can have damaging affects on the retina. In particular the macular region is vulnerable to blue light when exposed over extended periods of time.[5]

One might think that the use of tinted CLs would reduce visual acuity (VA), however, previous research with SportSight grey-tinted CLs has shown that VA is equal to or better than that of clear CLs.[6,7]

Nike MAXSIGHT™ tinted contact lenses claim to offer enhanced visual comfort by reducing brightness and glare throughout the full visual field, while also improving contrast recognition by filtering short-wavelength light, also known as blue light.[10] A

study with SportSight CLs demonstrated improved absolute threshold VA as well as improved tachistoscopic and timed low contrast VA.[8]

Nike MAXSIGHT™ lenses are available in two tints, grey-green and amber. The grey-green tint is designed for outdoor activities, such as trail running, mountain biking, water sports, and golf. The amber lens is designed for high-speed ball sports where a ball must be tracked against the background of the playing field and/or sky, such as soccer, tennis and baseball.

This study investigates the impact of Nike MAXSIGHT™ CLs on: speed of visual recovery when exposed to bright conditions; low contrast visual acuity in bright settings; the ability to adapt to changes between bright and shaded conditions; and visual comfort in bright sunlight.

Methods

Subjects

An Institutional Review Board proposal for the use of human subjects in research was submitted and approved. Thirty-three subjects (14 male, 19 female), ages 19-35, were selected from the Pacific University College of Optometry (PUCO) student body and surrounding community to participate in this study. All subjects signed an Informed Consent Form at the time of the initial screening. Subjects were compensated for participating in the study with a pass to the Nike employee store located in Beaverton, Oregon.

Subjects were required to pass a vision screening for participation in the study. The screening took place in the PUCO contact lens lab. Binocular VAs were measured

under normal room illumination with a Snellen chart at 6m. Subjects were required to wear a spherical Optima@38 contact lens during the VA measurement. Visual acuity of 20125 or better was required through the habitual refractive compensation. Fit of the experimental CL was assessed with a biomicroscope to assure an acceptable fit. Subjects could have no history of anterior segment pathology that would contraindicate soft CL wear.

Materials

Subjects were fit with Bausch and Lomb (B&L) Optima@38 clear CLs, Nike MAXSIGHT™ Amber CLs with 50% visible light transmission (VLT), and Nike MAXSIGHT™ Grey-Green CLs with 36% VLT. Plano lenses were used for subjects with no habitual refractive correction; B&L provided plano Optima@38 lenses for this study.

Procedures

Environmental Conditions: All testing was performed during the hours of 10:00 a.m. to 2:30 p.m. between November 2 and November 19,2005. Weather conditions were bright and sunny, varying from no clouds to thinly scattered high clouds. Testing was postponed if clouds covered the sun.

To increase overall luminance of the test areas, white cotton sheets were used to cover the ground between the subject and chart. The sheets also formed a uniform backdrop for each test area. A shaded area was constructed from PVC pipe and black felt to obstruct direct sunlight from illuminating a chart (see Figure 1). To reduce any light from reflecting into the shadowed area, black cloth was placed on the ground between the

subject and the chart. The testing set-up was rotated to maintain direct illumination from the sun.

Low contrast VA was always tested first, followed in order by alternating fixation in bright and shadowed conditions at distance, and the Haynes Distance Rock test in bright and shadowed conditions. All testing was conducted under binocular viewing conditions.

Fitting and Education: The sequence of CLs for each subject was counter-balanced using a 4x4 Latin Square design. Visual acuities were assessed before and after insertion of the contact lenses. In order to prepare the subjects to provide feedback on lens performance, each subject was asked to read a questionnaire that they would complete after each CL modality.

Before exiting the building subjects were given the Haynes Distance-Rock test instructions. Each subject was given welding goggles (number 10 neutral density filter) before leaving the building in order to reduce retinal saturation effects from the sun. The goggles were worn during all non-testing times while outside, including between each test. .

Low Contrast VA: Low contrast VA was assessed at 4m with two different test conditions: timed presentation and absolute threshold. Two 10% contrast Bailey-Lovie acuity charts were alternately used during these tests to avoid memorization of the letters.

Timed Presentation: This procedure was designed to assess the ability to recover low contrast visual acuity in bright sunlight following a short period of dark adaptation. Before testing, each subject was read the following instructions:

When I say 'GO,' *immediately remove your goggles and look at the isolated line of letters directly in front of you. Please call out the first letter of that line as soon as you can see it. Afterwards immediately put the goggles back on.*

The evaluator used a stop watch to time how long, in seconds, it took the subject to call out any letter from an isolated line of five 20/25 letters.

Absolute Threshold: A whole chart, low contrast threshold VA was measured in bright, sunlight. Before testing, each subject was read the following instructions:

When **I** *say* 'GO,' *please remove the goggles and take as much time as you need to call out the lowest line you can see on the chart directly in front of you. After calling out this line, immediately place the goggles back on.*

The estimated VA was recorded. As a note, the subjects were not timed at this station.

Alternating between bright and shaded conditions:

Two 10% contrast Haynes Distance Rock charts were positioned 4m in front of the subject; one chart in direct sunlight and the other in the shaded box. The Haynes Distance Rock Test protocol (see Appendix A) was modified to have the subject alternate fixation between the two far charts for one minute. Prior to testing, each subject was read the following instructions:

In *front of you there are two charts, one in the sunlight and one in the shadow. This test will be conducted like the example you were shown in the building; however, this time you will be alternating your view between the sunlit and shaded charts. When I say* 'GO,' *remove the goggles and call out the first* U R G E *letter on the top of the sunlit chart, then quickly look to the shaded chart and call out the first* U R G E *letter on it. Look back at the lit chart and call out the second letter, then back the shaded chart and call out the second letter and so on. Alternate between the charts as quickly as you can while being as accurate as possible. Continue until I say* STOP. *Then immediately replace the welding goggles.*

Similar instructions were read for the smaller letter (20125) demand. The number-of-cycles were recorded for each letter size.

Distance ***Rock:*** A low contrast Haynes Distance Rock chart was located in the shadow box at 4m, and a 10% contrast, reduced Haynes-Rock chart held at 40cm in bright sunlight. The Haynes Distance Rock Test protocol (see Appendix A) was followed, except the testing duration was increased to one minute. Prior to testing, each subject was read the following instructions:

*When I say '**GO,**' remove the goggles and call out the first **LARGE** letter on top of the sunlit chart in the distance, then quickly look to the card held in your hand and call out the first **LARGE** letter on the card. Look back to the sunlit chart in the distance and call out the second letter, then back to the card held in your hand and call out the second letter there. Alternate between the two charts as quickly as you can while being careful to be as accurate aspossible. Continue until I say **STOP,** then immediately replace the welding goggles.*

Subjective Questions: Following testing with each contact lens modality, subjects completed a questionnaire (see Appendix B) regarding their experience with that CL. Following completion of all three contact lens modalities, each subject was asked to directly compare the performance of each contact lens on a post-test survey (see Appendix C).

Figure 1. "Shadow Box"

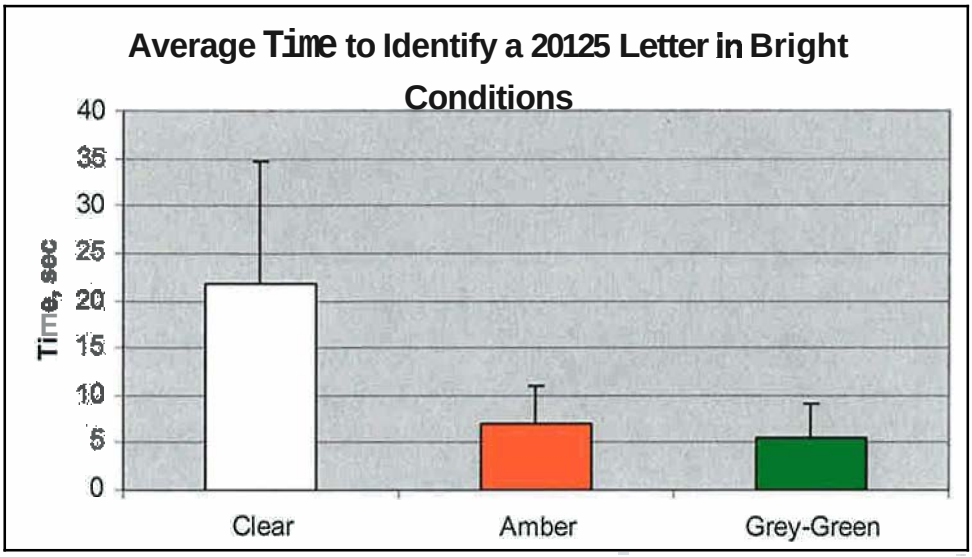
Results

Objective Data

Timed Presentation

Timed presentation results are shown in Figure 2. On average MAXSIGHT Amber and Grey-Green lenses provided a significantly quicker recovery time as compared to the clear lens, $F(2,64)=50.98$, $p=0.000$. There was no significant difference between the Amber and Grey-Green lenses.

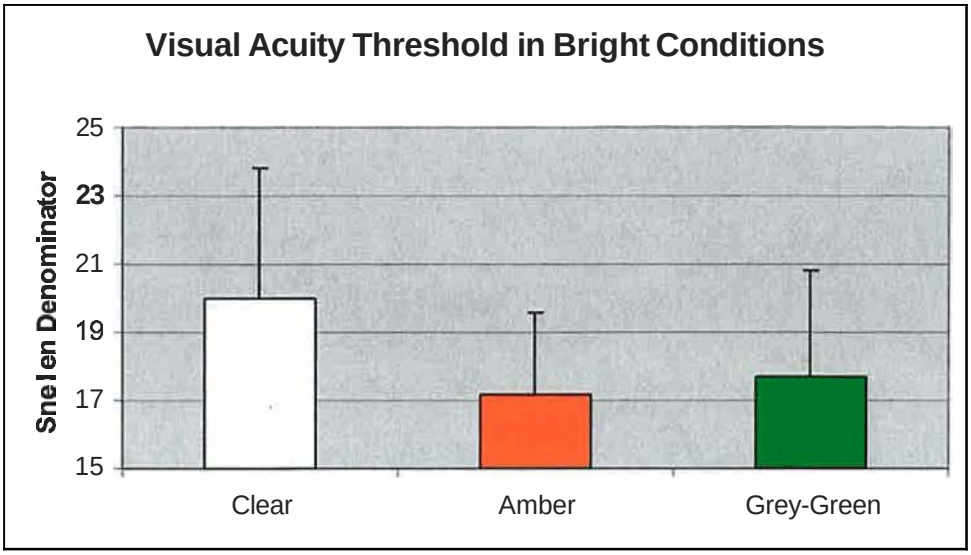
Figure 2 Timed Presentation



Absolute Threshold

Absolute threshold visual acuity results are shown in Figure 3. On average MAXSIGHT Amber and Grey-Green lenses provided a significant improvement in visual acuity over clear lenses, $F(2,64)=14.47$, $p=0.000$. There was no significant difference measured between the Amber and Grey-Green lenses.

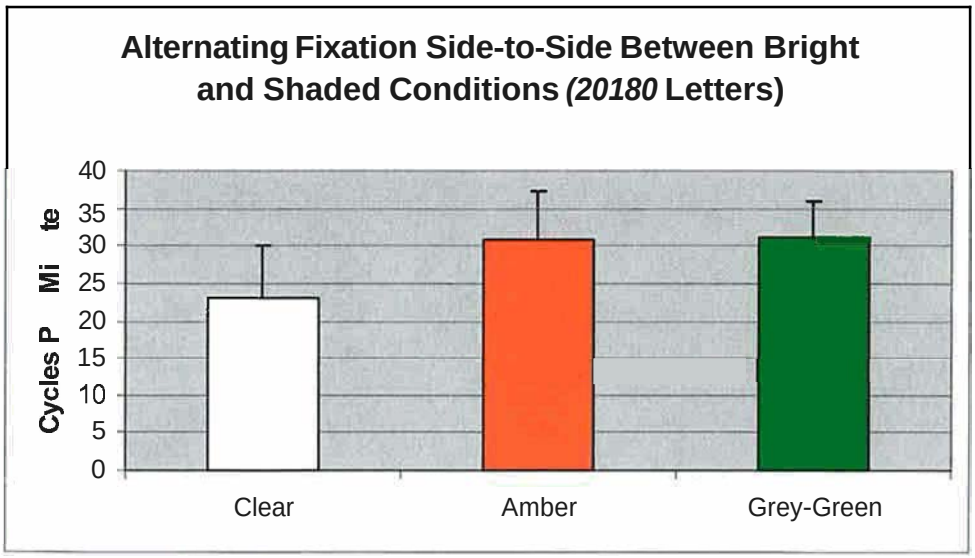
Figure 3 Absolute Threshold



Alternating Fixation

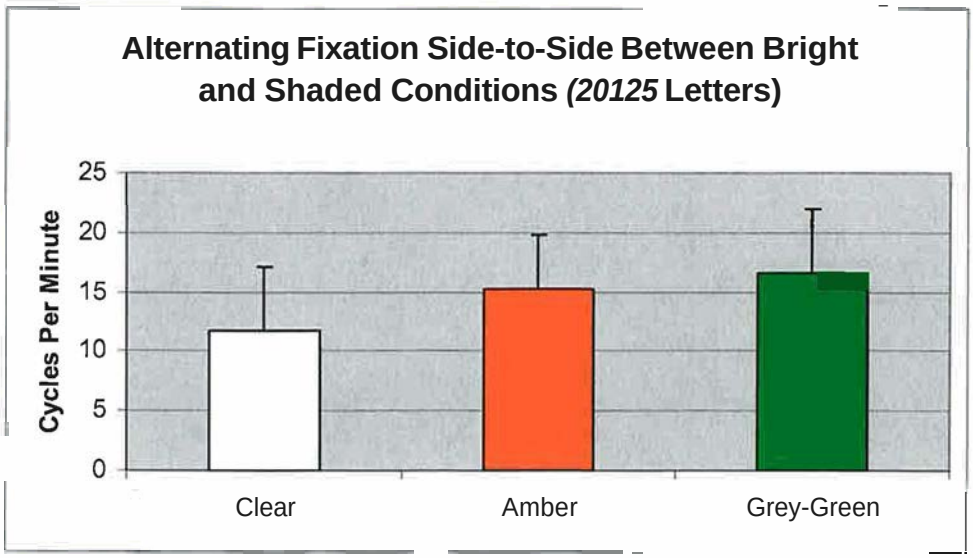
Results for the alternating fixation between bright and shadowed 20/80 Distance Rock charts at 4m are shown in Figure 4. On average when subjects wore MAXSIGHT Amber and Grey-Green lenses they completed a significantly greater number of cycles between the two charts, $F(2,64)=28.14$, $p=0.000$. There was no significant difference measured between the Amber and Grey-Green lenses.

Figure 4 Alternate fixation of 20180 letters



Results of alternate fixation between bright and shadowed 20125 Distance Rock charts are shown in Figure 5. On average when subjects wore MAXSIGHT Amber and Grey-Green lenses they completed a significantly greater number of cycles between the two charts, $F(2,64)=9.51$, $p=0.000$. There was no significant difference measured between the Amber and Grey-Green lenses.

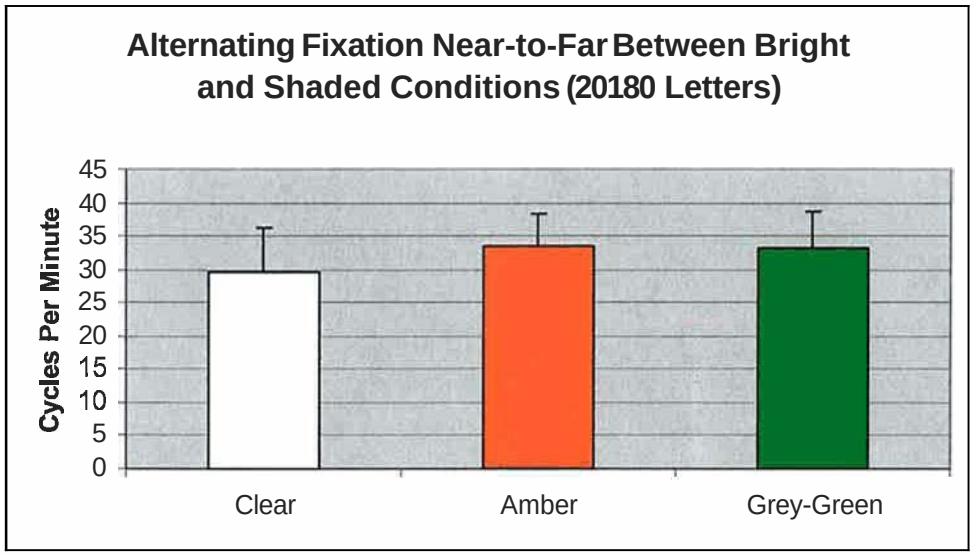
Figure 5 Alternate fixation of 20125 letters



Distance Rock

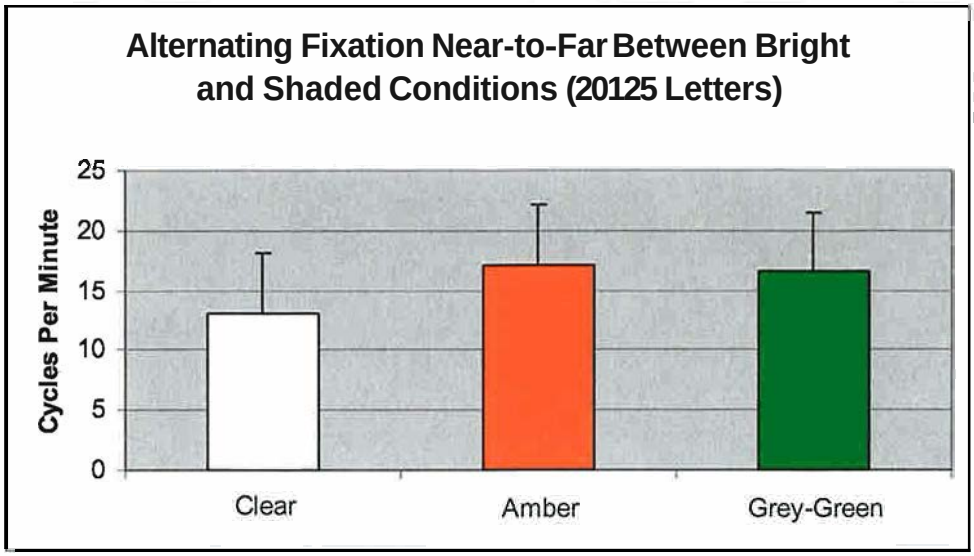
Results from the distance rock of 20/80 demand letters are shown in Figure 6. On average when subjects wore MAXSIGHT Amber and Grey-Green lenses they completed a significantly greater number of cycles between the two charts, $F(2,64)=9.49$, $p=0.000$. There was no significant difference measured between the Amber and Grey-Green lenses.

Figure 6 Haynes Distance Rock of 20180 letters



Results from the distance rock of 20/25 letters are shown in Figure 7. On average when subjects wore MAXSIGHT Amber and Grey-Green lenses they completed a significantly greater number of cycles between the two charts, $F(2,64)=8.64$, $p=0.000$. There was no significant difference measured between the Amber and Grey-Green lenses.

Figure 7 Haynes Distance Rock of 20/25 letters



Subjective Data

Subjective responses were obtained to determine if there was a significant difference in physical comfort, visual distortion/obstruction, visual comfort, effects of bright sun, visual transition from bright to shadowed conditions and vice versa, effect of stray light on vision, and overall lens performance (see appendix B) (can we summarize by saying...obtained to determine if there was a perceived benefit of the MAXSIGHT in the different conditions.) There was no significant difference between the clear lenses and the MAXSIGHT lenses in physical comfort ($\chi 2 = 8.23, p = 0.607$), or visual distortion/obstruction ($\chi 2 = 6.98, p = 0,323$). There was a significant difference between the clear lenses and the MAXSIGHT lenses, but no significant difference between the Grey-Green and Amber MAXSIGHT lenses, in each of the remaining subjective responses (see Table 1). All of the subjective data from all three lenses are compared in figure 8.

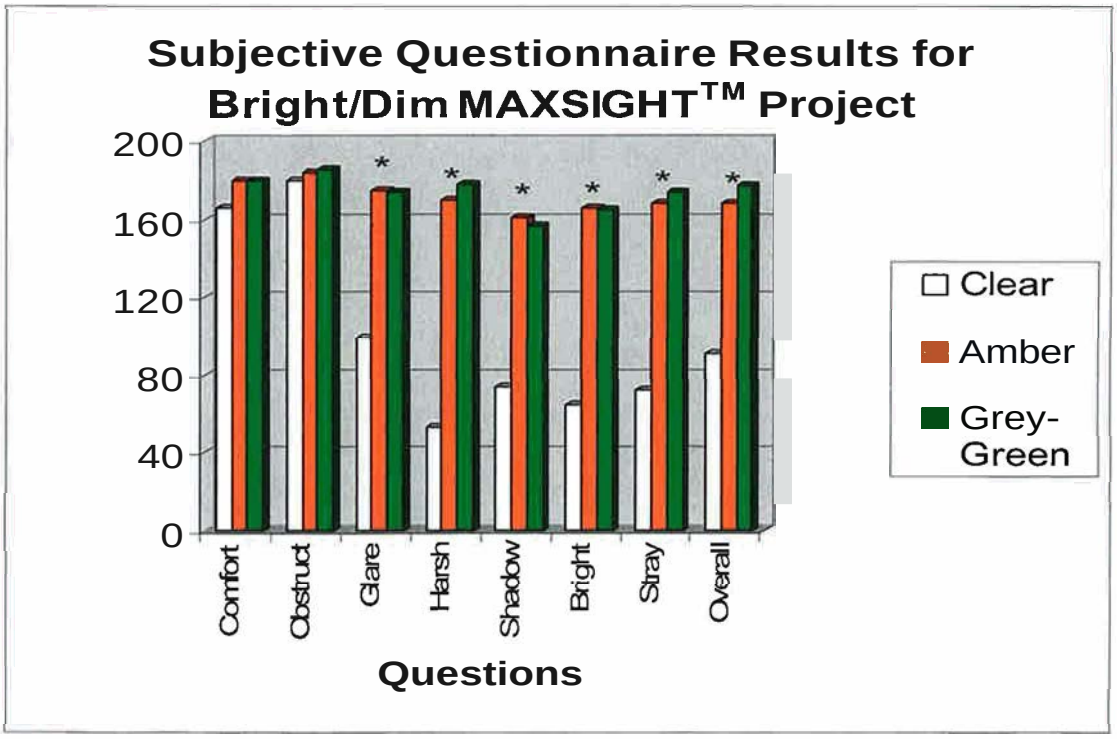
Table 1

	Glare	Harsh	Shadow	Bright	Stray	Overall
$\chi 2$	51.32	97.37	60.70	76.83	82.60	69.41
p-value	0.000	0.000	0.000	0.000	0.000	0.000

Table 2

	Comfort	Obstruct	Glare	Harsh	Shadow	Bright	Stray	Overall
Clear	166	180	99	53	74	65	72	91
Amber	180	184	175	170	161	166	168	168
Grey-Green	180	186	174	178	157	165	174	177

Figure 8. Data from Table 2 is shown graphically. The larger the number represents greater subject satisfaction.



Discussion

Visual Recovery Speed

The timed presentation procedure was designed to assess the ability to recover low contrast visual acuity in bright sunlight following a short period of dark adaptation. Results showed that when the MAXSIGHT™ lenses were worn, the subjects improved visual recovery time by an average of 15.52 seconds. In sports where an athlete may compete for an extended period of time in relatively low light conditions, the transition into bright sunlight can be difficult for recovery of visual acuity and contrast sensitivity. For example, a baseball player may spend considerable time in the dugout before taking the field to bat or field in bright sunlight. The results of this study suggest that the baseball player wearing MAXSIGHT lenses would recover crucial visual function quicker than the athlete wearing clear contact lenses.

Low Contrast Visual Acuity in Bright Sunlight

Nike MAXSIGHT™ lenses were found to significantly improve low contrast VA in bright sunlight when compared to clear contact lenses. Subjects achieved nearly a line improvement in VA while wearing the tinted lenses,. **A** number of sport situations contain subtle visual information with varying contrast conditions. For example, it is essential for a golfer to accurately identify subtle variations in the surface of the green. The results of this study suggest that MAXSIGHT lenses may enhance a golfer's low contrast VA.

Alternating between Bright and Shaded Conditions

Visual recovery speed was assessed by challenging the subjects to alternately discriminate low contrast visual acuity targets in bright sunlight and shaded conditions. The number of completed cycles when looking between a chart in direct sunlight and a chart in a shadow box significantly improved when the subjects wore the Nike MAXSIGHT™ lenses. This improvement was consistent when the targets were *20125* letters, *20180* letters, and when done from near to far with *20125* and *20180* letters. Recovery of vision when transitioning between shadowed conditions and bright sunlight is a critical element in many sports. In soccer, for example, shadows often cover a portion of the pitch. A soccer ball is a high contrast target when stationary, but significantly reduced contrast when kicked with a large amount of spin. Since the spin of the ball provides vital clues concerning the flight trajectory of the ball, the ability to discriminate the contrast of the ball pattern is potentially beneficial to the athlete. This study suggests that MAXSIGHT lenses may facilitate a quicker transition when the ball moves between shaded and sunny conditions.

The ability to recover visual function when alternating between shaded and bright conditions was also assessed with the Haynes Distance Rock Test. One study demonstrated a high correlation between performance on the standard Haynes Distance Rock Test and athletic performance.[9] Similar to the preceding results, this study revealed improved performance with the MAXSIGHT lenses compared to clear contact lenses.

Subjective Results

Subjects rated Nike MAXSIGHT™ lenses significantly better in most categories. Subjects did not report any difference in physical comfort or visual distortion between the clear and tinted lenses. MAXSIGHT™ Amber and Grey-Green lenses were judged to provide superior visual performance in bright and shadowed conditions. Overall, subjects preferred the MAXSIGHT lenses compared to clear contact lenses.

Future Considerations

This study was limited to two commercially available tinted contact lenses. There was no significant difference between the measured performances of the two tints. Future studies could investigate other performance tints to determine if tint color affects specific aspects of visual performance. Similarly, tint density could be assessed to determine any potential impact on visual performance. In sports where the bright glare of artificial lighting is a perceived problem, tints designed for use with stadium lighting could be examined.

Future studies could modify the research design by using high-level athletes as subjects, and use actual visual tasks from sports (e.g. judging the spin on a baseball pitch) to assess visual performance. The use of welding goggles to preserve dark adaptation in this study could also be modified to determine differences in visual performance. This study assessed visual performance with tinted contact lenses; a similar study could be performed with sun eyewear.

Summary

The results of this study show that Nike MAXSIGHT™ lenses improve contrast discrimination and speed of visual recovery in bright sunlight. MAXSIGHT lenses also provided better contrast discrimination when alternating between bright and shaded conditions. Subjective responses reveal that MAXSIGHT were judged to provide superior visual performance. Visual factors that are critical in sports performance, including subtle contrast discrimination and visual recovery when transitioning between bright and shaded conditions, are enhanced with MAXSIGHT lenses.

Appendix A

Distance Rock

E: Accommodation / vergence facility in changing from a *40* cm to a 6 cm (etc) visual target under two visual acuity (VA) demand conditions, *20180* and *20125.*

I: Haynes Distance Rock Test Charts

TD: Near chart at *40* cm, distance chart at 6 m.

IL: Standard room (34-79 footcandles at both charts).

P: Standing relaxed

CF: Must keep both eyes open at all times. The near chart should be held just below eye level and on line with the distance chart.

IS: Introduce test and demonstrate. "I'd like you to look quickly back and forth between this close chart and the other chart in the distance. Call the first letter on the near chart, then quickly look to the far chart and call the first letter on it. Look back quickly and call the second letter on the near chart, then again look to the far chart, and so on. Go as quickly as you can, but be careful not to lose your place. Make the letters clear and single when you look at either chart. Call only the large letters first, then we'll start again and I'll have you call only the small letters. Should you finish all the letters before time has been called, return to the first letter called and begin again."

R: Record the number of near-far cycles completed without error in 30 seconds at each of the two VA demand levels (omit one cycle for each error). One cycle consists of a shift from near to far, then back to near. You can easily determine the number of cycles completed by subtracting 1 from the total count of letters called on the near chart.

Appendix B

A Comparison of Visual Recognition Speed and Accuracy when Alternating Fixation between Bright and Shadowed Conditions with Maxsight Contact Lenses

Amber

Subject # _____ ***Date:*** ___/___/___

Please circle the number that best fits your experience/opinion during today's testing.

	Strongly Agree					Strongly Disagree
Comfort						
-Lenses are comfortable	1	2	3	4	5	6
Vision						
-Lenses do not obstruct or distort vision	1	2	3	4	5	6
-Lenses provide exceptional visual comfort (Relaxed, no glare or squinting)	1	2	3	4	5	6
-Lenses reduce the effects of harsh, bright sun on my eyes	1	2	3	4	5	6
-Lenses enhance visibility when looking into shadow from bright sun	1	2	3	4	5	6
-Lenses enhance visibility when looking into bright sun from shadow	1	2	3	4	5	6
-Lenses reduce the effect of stray light on my vision	1	2	3	4	5	6
Overall Performance						
- Overall, lenses performed very well	1	2	3	4	5	6

Additional Comments:

Appendix C

A Comparison of Visual Recognition Speed and Accuracy when Alternating Fixation between Bright and Shadowed Conditions with Maxsight Contact Lenses

Post Test Survey

Subject # _____ ***Date:*** ___/___/___

Please rate the following when comparing the Clear, Amber and Grey-Green Contact Lenses:

Overall visual comfort is superior (Superior = relaxed, no glare or squinting)	Strongly Agree					Strongly Disagree
Clear	1	2	3	4	5	6
Amber	1	2	3	4	5	6
Grey-Green	1	2	3	4	5	6

Overall visual performance is superior (Superior = clear, efficient target visibility)						
Clear	1	2	3	4	5	6
Amber	1	2	3	4	5	6
Grey-Green	1	2	3	4	5	6

Additional Comments:

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