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The effects of MaxSight contact lenses on objective and subjective measures of golf putting performance

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The effects of MaxSight contact lenses on objective and subjective measures of golf putting performance

Abstract
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Methods Study participants consisted of a cohort of 31 high level golfers with single digit handicaps. Each subject completed a four hole putting course using Bausch & Lomb Optima 38 clear contact lenses and Nike MAX SIGHT™ contact lenses. Subjects completed two putts from four positions at each hole; the four putts were setup within a 30-degree arc at each hole. At each hole, the putt directions were oriented at different directions relative to the sun, e.g., north, south, east, and west. The sequence was randomized and the subject’s performance was recorded. During and after the study, subjective questionnaires were given to each participant to evaluate the contact lens modalities and their respective performance.

Results Chi-square analysis of the putting results was performed to compare contact lens performance. Subjective responses were also analyzed to assess perceived differences between contact lens modalities. Results indicated that there was no statistically significant difference in putting performance between contact lens modalities. Statistically significant differences were observed in the subjective responses revealing that Nike MAX SIGHT™ contact lenses were preferred for visual comfort and performance.

Conclusion Although actual putting performance showed no statistically significant difference between the two modalities, Nike MAXSTGF Grey-Green lenses were perceived to improve the golfer’s ability to read the green, Nike MAXSTOP Grey-Green lenses provided better visual comfort and may impact overall performance by reducing visual fatigue during play.

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Graham B. Erickson

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THE EFFECTS OF MAXSIGHT CONTACT LENSES ON OBJECTIVE AND
SUBJECTIVE MEASURES OF GOLF PUTTING PERFORMANCE

By

KOLLAN P. ARRITT
AUSTIN 3. HORNBERGER

A thesis submitted to the faculty of the
College of Optometry
Pacific University
Forest Grove, Oregon
for the degree of
Doctor of Optometry
May 2007

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Acknowledgments:

We would like to thank Dr. Graham Erickson, Dr. Fraser Horn, and Dr. Karl Citek for all of their guidance and support in completing this project. We are also very appreciative of Nike and Bausch and Lomb for providing materials and financial support and to Dick Speros and the Forest Hills Golf Course.
ABSTRACT

Background

Nike MAXSIGHT™ Grey-Green contact lenses claim to enhance visual performance in golf by reducing brightness and glare. The grey-green tint is designed to enhance the details of the environment, such as green grass. A critical aspect of golf performance is putting. This study compares golf putting performance with MAXSIGHT and clear contact lenses.

Methods

Study participants consisted of a cohort of 31 high level golfers with single digit handicaps. Each subject completed a four hole putting course using Bausch & Lomb Optima 38 clear contact lenses and Nike MAXSIGHT™ contact lenses. Subjects completed two putts from four positions at each hole; the four putts were setup within a 30-degree arc at each hole. At each hole, the putt directions were oriented at different directions relative to the sun, e.g., north, south, east, and west. The sequence was randomized and the subject's performance was recorded. During and after the study, subjective questionnaires were given to each participant to evaluate the contact lens modalities and their respective performance.

Results

Chi-square analysis of the putting results was performed to compare contact lens performance. Subjective responses were also analyzed to assess perceived differences between contact lens modalities. Results indicated that there was no statistically
significant difference in putting performance between contact lens modalities. Statistically significant differences were observed in the subjective responses revealing that Nike MAXSIGHT™ contact lenses were preferred for visual comfort and performance.

Conclusion

Although actual putting performance showed no statistically significant difference between the two modalities, Nike MAXSIGHT™ Grey-Green lenses were perceived to improve the golfer’s ability to read the green. Nike MAXSIGHT™ Grey-Green lenses provided better visual comfort and may impact overall performance by reducing visual fatigue during play.
Introduction

Tinted eyewear can reduce undesirable glare and brightness, protect the eyes from potentially harmful radiation, and increase color contrast discrimination. MacEwen points out, "...it is clear that any person who plays sport out of doors has an increased risk of light damage as there is increased exposure to solar radiation." On a sunny day, illuminance can range from 1,000 to 10,000 foot-lamberts, which saturates the retina and reduces contrast sensitivity at higher spatial frequencies. Coatings and dyes designed to filter harmful ultraviolet (UV) light are common in the eyewear market. UV radiation under 380nm has been shown to cause damage to the cornea, uvea, lens, and retina. Tinted sunglasses often filter a significant portion of the incident UV radiation, while also helping to recover contrast sensitivity and dark adaptation following saturation of photoreceptors.

In addition to sun eyewear providing a protective function, specialized tints have been designed to filter specific wavelengths in order to enhance athletic performance. For example, skiers and target shooters may use yellow filters in certain light conditions. Yellow filters have been shown to improve depth perception, contour recognition, and reaction times. Chromatic aberration is cited as the most significant aberration in the well-corrected human eye, and filters that diminish transmission of the short wavelength (blue) portion of the visible light spectrum improve retinal image quality by reducing the amount of chromatic aberration.

Despite the benefit athletes may gain from filter use, many are not willing to wear sun eyewear because of problems with comfort and performance. In a survey of optometrists, 62% feel that there are inherent disadvantages with using non-prescription
Sunglasses in sports. Spectacle lens disadvantages include peripheral distortion, image doubling and scotomas at lens edges, restricted or reduced field of view, peripheral light leakage, lens surface reflections, lens scratches, and moisture or debris accumulation. Additional frame drawbacks cited include discomfort, storage issues, cosmetic appearance, and maintenance of the eyewear.

Tinted contact lenses may provide potential solutions to some of the disadvantages mentioned with sun eyewear. Schnider et al. compared visual performance of spectacles versus contact lenses using the Pacific Sports Visual Performance profile™:

Subjects found clear contact lenses to be superior to clear spectacles in issues related to glare, peripheral vision and likelihood of displacement with strenuous activity. Patient perceptions indicated that there may be important psychological advantages to wearing contact lenses for leisure and/or sporting activities. Reichow et al. found that contact lenses are preferred for refractive error correction for athletes because they ameliorate most of the disadvantages of using spectacles in sports. Of the optometrists surveyed, 97% preferred contact lenses to spectacles for patients who are athletes. Likewise, Athletic Trainers-Certified (ATCs) reported that 95% of NCAA Division IA athletes, 65% of Division III athletes, and 89% of professional athletes requiring vision correction wear contact lenses. The majority of optometrists and ATCs expressed interest in performance-tinted contact lenses for their athletes. The benefits of selective filters combined with the benefits of contact lenses potentially provide significant performance advantages. Mark McGwire, a former home run champion, reported increased peripheral vision, reduced glare, and clearer and crisper vision while wearing yellow tinted contact lenses.
Many of the benefits of tinted eyewear may also apply to golf. Golf equipment, including golf-specific eyewear, is promoted to enhance playing performance. There are various companies that offer golf eyewear with a variety of tints, polarization, and designs. However, many golfers feel that sun eyewear used during play is of little benefit. There may be many factors that contribute to this perception. Jim Furyk, a leading golfer on the PGA Tour, has stated in USA Today, "I haven't found a pair I can be comfortable with and read the greens."  

The American Optometric Association Sports Vision Guidebook on golf states that "...golfers can utilize photochromic lenses or distortion free sunglasses to prevent squinting and eye fatigue."28 Lampert suggests that golf sun eyewear should "...block [ultraviolet] and infrared, be ground and polished with no distortion, be easy on the eyes, be large enough but not block periphery, and be a safe impact-resistant lens."29 Nike MAXSIGHT contact lenses provide the appropriate sun protection recommended by Lampert while not blocking or distorting peripheral vision as many sunglasses do.  

Optics, tint, and physical characteristics of sun eyewear alter the information provided to the visual system of the wearer. Many variables within the visual system affect a golfer's ability to read the green, align the putt, and assess the distance of the putt. Coffey et al. reported that contrast sensitivity, visual acuity, and stereopsis tend to be better in professional golfers compared to amateurs.30 Prismatic effects induced by the lens design of the sun eyewear may also be noticed by golfers. Contributing factors to prismatic effects include the steep front and back lens curves, the tilt of the lens, lens thickness, and manufacturing abnormalities. Premium sports eyewear was found to have significant amounts of prism in both primary and lateral gaze.31 Farnsworth and Smith
reported that “...most players did not believe sunglasses tints improved golf performance, despite acknowledgment that wearing sunglasses reduced visual fatigue.”

This study investigates the subjective and objective impact of Nike MAXSIGHT™ contact lenses on golf putting performance. The information from this study may assist eye care practitioners in providing recommendations regarding sun eyewear use for golf.

Methods

Study Location and Course Set-up

The study took place at the Forest Hills Golf Course in Cornelius, Oregon, which is located at approximately 45.5 degrees North latitude. Testing took place in September and October of 2005. All testing took place between 10:00 AM and 5:00 PM. The putting green was set up with five holes: one for practice; and four for testing. The four test holes were set up so that each putt measured 6m (20 feet) from the hole. Subjects completed two putts from four positions at each hole; the four putts were setup within a 30-degree arc at each hole (see Fig. 1). At each hole, the putt directions were oriented at different directions relative to the sun, e.g., north, south, east, and west (see Fig. 2).

Materials

MAXSIGHT tinted contact lenses (CLs) and clear Optima 38 CLs were supplied by Bausch & Lomb. The CLs had an 8.4mm base curve and a 14.0mm diameter. The MAXSIGHT lenses had a grey-green tint with 36% visible light transmission (VLT). The clear lenses contain the standard light blue visibility tint with 89% VLT.
Procedure

Sequence: Instructions were given at the practice hole and the subjects were allowed to practice for approximately 5 minutes. Subjects were instructed as follows:

"Prior to each putt, use the same pre-shot routine as you would during regular tournament play. After striking each putt, a partition will drop obscuring your view. Also, foam will be placed in the cup to take away any feedback as to the success of the putt. After measuring the location of your putt, the partition will be removed and you will take your next putt. You will be attempting 2 putts at 4 different locations per hole. Upon completing the four holes you will proceed to a different hole where you will be given a questionnaire regarding the lenses you are wearing. We will then switch the contact lenses and repeat a similar putting sequence. After completing the putting phase, you will go to the Contact Lens Insertion and Removal table where any question you may have about contact lens care will be answered. Once again, we would like you to putt as if you are in tournament play."

Subjects were asked to putt sixteen times at each hole, eight times with each contact lens modality. Subjects received no visual or verbal feedback on the result of each putt. After striking each putt, a partition was dropped to obscure the subject's view of the putt result (see Fig. 3). In addition, foam padding was placed in each hole to eliminate auditory feedback from made putts.

The final location of each putt was identified as being made, or in one of four quadrants (see Fig. 4). Since golfers actually attempt to putt beyond the hole, we would expect most missed putts to end in the two quadrants beyond the hole. If the putt ended on a line separating two quadrants, it was assigned to the adjacent quadrant counterclockwise to the ball location. The distance from the closest edge of the cup to the front edge of the ball was measured in centimeters with a measuring tape. A value of zero was assigned to putts that ended in the hole.

Following testing with each lens modality, subjects completed a questionnaire regarding the performance of the contact lens (see Appendix 1). After completion of
testing with both lens modalities, subjects completed a comparative questionnaire (see Appendix 2).

Results

Statistical analyses were performed to identify differences in the data based on factors of contact lens modality and sun direction. Subjective responses regarding contact lens comfort and performance were also analyzed to determine perceived differences.

Putt Endpoint Error

Chi-square ($\chi^2$) analysis of the non-parametric putt placement data reveals that there is a significant interaction effect between the contact lens modalities and the holes, $\chi^2(28) = 177.3$, $p = 0.000$. This overall difference is due to a statistically significant difference in the main effect for holes, $\chi^2(12) = 150.9$, $p = 0.000$. However, there is no significant difference in the main effect for contact lens modality, $\chi^2(4) = 4.17$, $p = 0.383$.

Repeated-measures analysis of variance of the parametric putt distance error data reveals that there were no significant effects based on contact lens modality, $F(1,1983) = 0.33$, $p = 0.568$; hole, $F(3,1981) = 2.14$, $p = 0.093$; nor interaction of modality and hole, $F(7,1977) = 1.15$, $p = 0.331$ (see Fig. 5).

Subjective Preferences

Chi-square analysis of the subjective responses following each contact lens modality during the study showed statistically significant differences in comfort and performance in questions 5-12 (see Fig. 6). The MAXSIGHT grey-green CL was preferred with regard to the factors relating to sun effects, contrast, and depth perception.
Questions 1-4 showed no statistical difference based on comfort and clarity factors. Subjects demonstrated no statistically significant preference for either CL modality with regard to overall performance (see Table 1).

**Table 1:** Contact Lens Modality Questions

<table>
<thead>
<tr>
<th></th>
<th>Chi^2</th>
<th>d.f.</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comfort</td>
<td>0.08</td>
<td>3</td>
<td>0.994</td>
</tr>
<tr>
<td>Clear</td>
<td>3.05</td>
<td>3</td>
<td>0.384</td>
</tr>
<tr>
<td>Obstruct</td>
<td>3.76</td>
<td>3</td>
<td>0.288</td>
</tr>
<tr>
<td>Vis Comfort</td>
<td>8.4</td>
<td>4</td>
<td>0.078</td>
</tr>
<tr>
<td>Harsh</td>
<td>30.7</td>
<td>5</td>
<td>0.000</td>
</tr>
<tr>
<td>Details</td>
<td>24.8</td>
<td>5</td>
<td>0.000</td>
</tr>
<tr>
<td>Towards Sun</td>
<td>30.8</td>
<td>5</td>
<td>0.000</td>
</tr>
<tr>
<td>Away from Sun</td>
<td>21.5</td>
<td>5</td>
<td>0.001</td>
</tr>
<tr>
<td>Lateral to sun</td>
<td>24.6</td>
<td>5</td>
<td>0.000</td>
</tr>
<tr>
<td>Stray Light</td>
<td>29.8</td>
<td>5</td>
<td>0.000</td>
</tr>
<tr>
<td>Enhance Contrast</td>
<td>29.6</td>
<td>5</td>
<td>0.000</td>
</tr>
<tr>
<td>Depth</td>
<td>20.3</td>
<td>5</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Subjective preferences at the conclusion of the study comparing CL modalities are shown (see Table 2).

**Table 2.** Results of Subjective Questionnaire Comparing Contact Lenses After Testing

<table>
<thead>
<tr>
<th></th>
<th>Clear</th>
<th>Grey-Green</th>
<th>No Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior visual comfort</td>
<td>3</td>
<td>21</td>
<td>7</td>
</tr>
<tr>
<td>Details of the green</td>
<td>6</td>
<td>22</td>
<td>3</td>
</tr>
<tr>
<td>Read the green</td>
<td>4</td>
<td>17</td>
<td>10</td>
</tr>
<tr>
<td>Enhanced contrast</td>
<td>3</td>
<td>25</td>
<td>3</td>
</tr>
<tr>
<td>Improved depth perception</td>
<td>6</td>
<td>7</td>
<td>18</td>
</tr>
<tr>
<td>Best visibility with shadows on the green</td>
<td>4</td>
<td>20</td>
<td>7</td>
</tr>
</tbody>
</table>

For 5 of the 6 questions, MAXSIGHT Grey-green CLs were preferred. Of the 31 subjects, 22 rated the grey-green tint as just right, 5 rated the tint as too dark, and 4 rated the tint too light. When subjects were asked if they would consider wearing the MAXSIGHT Grey-green CLs during play, 22 said yes, 3 said no, and 6 were unsure.
Only five of the 30 subjects reported wearing sun eyewear when playing golf, with three subjects wearing the eyewear when putting. Two of these subjects reported use of polarized eyewear.

Discussion

The results show that putting performance is not affected by Nike MAXSIGHP™ Grey-Green CLs when compared to clear CLs. Nike MAXSIGHT™ Grey-Green lenses did not demonstrate a beneficial or deleterious effect on putt endpoint error, as measured by distance or quadrant placement. There was a significant difference in the difficulty of the four test holes, with some holes producing larger putt endpoint errors than others. This effect is likely due to the differing direction of each hole with regard to the sun, and differing contour features creating greater difficulty in reading of the putt. However, the CL modality did not have a significant effect on putt endpoint error.

Nike MAXSIGHT™ Grey-Green lenses were judged to provide better visual comfort than the clear contact lenses. Participants preferred Nike MAXSIGHT™ Grey-Green lenses over clear lenses in harsh, bright, sunny conditions, and for the reduction of stray light. The superior comfort in harsh, bright, sunny conditions can be attributed to the Nike MAXSIGHP™ Grey-Green lenses ability to filter out approximately 64% of visible light (36% VLT) The Nike lens covers the entire cornea thus eliminating any distraction from stray light.

Nike MAXSIGHT™ Grey-Green lenses were perceived to improve the golfer's ability to read the green. Participants preferred the tinted lenses over clear lenses for their ability to read the details of the green, and for the perception of enhanced contrast and
depth perception. The Nike MAXSIGHT™ Grey-Green lenses were designed to enhance the green and red portions of the visible spectrum. By filtering some of the visible light, chromatic aberration is reduced and may improve detail and contour recognition\textsuperscript{17} such as the subtleties of green grass. However, the Nike MAXSIGHT™ Grey-Green lenses had no demonstrable effect on putting performance when compared to clear contact lenses.

Future experimental designs could include an analysis on the use of Nike MAXSIGHT™ Grey-Green lenses on all aspects in the game of golf. This study was solely focused on reading the green and putt endpoint error, and other aspects of the game may yield substantive performance differences. Nike MAXSIGHT™ Grey-Green lenses provided better visual comfort and may impact overall performance by reducing visual fatigue during play. A study of Nike MAXSIGHT™ Grey-Green lenses on visual comfort and performance over an extended period of time should be performed.
References


27. Hiestand M. The future is bright for shades. USA Today, 1999 Apr 21; Sect C: 3.


FIGURE 1

FIGURE 2- MAP OF GREEN

Legend:
○ = Hole Location
→ = Starting Position
Diagram not to scale
FIGURE 3

Figure 3- view of partition during putt performance
A. partition is raised prior to putt, B. partition obstructing view of putt performance

FIGURE 4 - GRID
Putt End-Point Measurement System
1 Quadrant
2 Absolute distance (cm)

****From the Perspective of the GOLFER****
FIGURE 5 - Putt Endpoint Error Plot
Key:
Solid = grey-green, Dashed = clear
Center of Circle Position = average endpoint error
Circle Size = number of putts ending in that quadrant

FIGURE 6 - Graphical presentation of subjective questionnaire results administered after each CL modality
APPENDIX 1
The Effects of MAXSIGHT Contact Lenses on Objective and Subjective Measures of Golf Putting Performance

**Test Day**
**Grey-Green**

Subject # ______ Date: ____ / ____ / ____
Please circle the number that best fits your experience/opinion during today's testing.

<table>
<thead>
<tr>
<th>Comfort</th>
<th>Vision</th>
<th>Over-all Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>-Lenses are comfortable</td>
<td>-Vision is vibrant and clear</td>
<td>- Over-all, lenses <strong>performed</strong> very well</td>
</tr>
<tr>
<td>Strongly Agree: 1 2 3 4</td>
<td>-Lenses do not obstruct or distort vision</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-Lenses provide exceptional visual comfort</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(relaxed, no glare, no squinting)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-Lenses reduce the effect of harsh, bright sun on my eyes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-Lenses enhance ability to see the details of the green (blades of grass, ball marks, dry spots, etc)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-Lenses enhance ability to read greens in bright sunny conditions when putting towards the sun</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-Lenses enhance ability to read greens in bright sunny conditions when putting away from the sun</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-Lenses enhance ability to read greens in bright sunny conditions when putting lateral to the sun (sun to your side)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-Lenses reduce effects of stray light</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-Lenses enhanced contrast</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-Lenses improved depth perception</td>
<td></td>
</tr>
</tbody>
</table>

Strongly Disagree: 5 6
The Effects of MAXSIGHT Contact Lenses on Objective and Subjective Measures of Golf Putting Performance

*Test Day*

*Clear*

*Subject # ________ Date: / /__*

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

<table>
<thead>
<tr>
<th>Comfort</th>
<th>Strongly Agree</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>-Lenses are comfortable</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Vision</td>
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<tr>
<td>-Vision is vibrant and clear</td>
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<td></td>
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<td></td>
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<td>-Lenses do not obstruct or distort vision</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-Lenses provide exceptional visual comfort (relaxed, no glare, no squinting)</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>-Lenses reduce the effect of harsh, bright sun on my eyes</td>
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<td></td>
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<tr>
<td>-Lenses enhance ability to see the details of the green (blades of grass, ball marks, dry spots, etc)</td>
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<td></td>
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<tr>
<td>-Lenses enhance ability to read greens in bright sunny conditions when putting towards the sun</td>
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<td></td>
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<tr>
<td>-Lenses enhance ability to read greens in bright sunny conditions when putting away from the sun</td>
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<tr>
<td>-Lenses enhance ability to read greens in bright sunny conditions when putting lateral to the sun (sun to your side)</td>
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<tr>
<td>-Lenses reduce effects of stray light</td>
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<td></td>
<td></td>
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<tr>
<td>-Lenses enhanced contrast</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>-Lenses improved depth perception</td>
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<td></td>
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</tbody>
</table>

**Over-all Performance**
- Over-all, lenses performed very well

**Additional Comments:**
APPENDIX 2
The Effects of MAXSIGHT Contact Lenses on Objective and Subjective Measures of Golf Putting Performance
Testing Day – Post Survey

Subject # _______ Date: __/__/____

Please circle your preferred response:

1. Which lens provided superior visual comfort (relaxed, no glare, no squinting):
   - Clear
   - Grey-Green
   - No Difference

2. Which lens offered an enhanced ability to see the details of the green (blades of grass, ball marks, dry spots, etc):
   - Clear
   - Grey-Green
   - No Difference

3. Which lens offered an enhanced ability to read the green:
   - Clear
   - Grey-Green
   - No Difference

4. Which lens offered enhanced contrast:
   - Clear
   - Grey-Green
   - No Difference

5. Which lens improved depth perception:
   - Clear
   - Grey-Green
   - No Difference

6. Which lens provided the best visibility with shadows on the green:
   - Clear
   - Grey-Green
   - No Difference

7. In your opinion, for overall performance on the green, was the grey-green tint:
   - Too dark
   - Just right
   - Too light

8. Based on your experience with the grey-green tinted contact lenses, would you consider wearing these for golf?
   - Yes
   - No
   - Not sure
   If no or unsure, why?

Additional Comments: