DESIGN CONSIDERATIONS TO FUTURE WEARABLE TECHNOLOGY DEVELOPERS: A VISUAL FIELD ANALYSIS OF GOOGLE GLASS

by

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This paper is submitted in partial fulfillment

of the requirements for the degree of

Doctor of Optometry

Ferris State University

Michigan College of Optometry

May 2016

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Has been approved

May, 2016

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Faculty Course Supervisor

Ferris State University
Doctor of Optometry Senior Paper
Library Approval and Release

Design Considerations for Wearable Technology

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ABSTRACT

Intro: Google Glass is the first major launch of headborne wearable technology. The frame is large over the right temple and the prismatic viewer screen is in front of the right eye's superior temporal field.

Purpose: The purpose of this study is to investigate the effect wearing Google Glass has on the normal human visual field (peripheral vision). With wearable technology becoming more readily available, it is important to thoroughly investigate its effects on the human body and its function. There currently exists a very small amount of published research about wearable technology. We hypothesize that the rigid and relatively bulky frame and prismatic screen of Google Glass will cause visual field restrictions that could be detrimental to driving tasks and, therefore, is contraindicated when behind the wheel.[1]

Methods: Participants with normal visual fields and 20/20 vision, either emmetropic or contact lens corrected, were properly fit with Google Glass. While wearing Google Glass, a central 30-2 visual field test of the right eye was conducted using a Humphrey Visual Field Analyzer.[2]

Results: Relative scotomas in the superior temporal quadrant of the right eye were present in 75% of participants. Only 14.94% of superior temporal points were statistically abnormal, with 85.94% being normal. Left eye dominant participants had a lower percentage of abnormal points, 5.56%. Two participants showed 50% of their superior temporal quadrant as abnormal.

Conclusion: The results of this study will impact the design of future wearable technology and the effects of technology like Google Glass has on the function of the human visual system. The only other published research regarding Google Glass and visual fields was limited by its small sample size- only three participants- but did show a consistent superior temporal visual field defect while wearing Google Glass. With over 30 study participants, our results will confirm or refute this evidence, providing valuable feedback to wearable technology companies and users.

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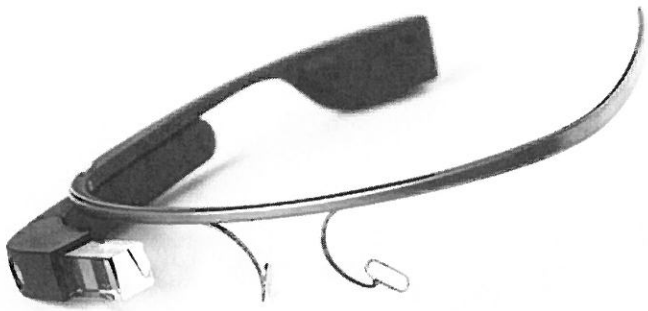
INTRODUCTION:

Wearable technology is a constantly growing and changing field. Google Glass is the first major launch of head borne wearable technology. The frame is large over the right temple and the prismatic viewer screen is in front of the right eye's superior temporal field. Since the launch of Google Glass, other companies have experimented with similar heads-up displays. Garmin has developed a similar looking product for cyclists. Heads-up displays pose as an interesting product to those in the eye care profession. These products have the potential to cause issues such as visual field obstructions, eye strain, and/or dry eye, among many others. The purpose of this preliminary study is to see if Google Glass causes a visual field defect. The large frame and display are suspicious of causing a visual field defect in the superior temporal quadrant.

METHODS:

Study participants who were either emmetropic or contact lens corrected to 20/20 visual acuity and with full-to-finger confrontational fields were instructed how to properly wear Google Glass (n=32). These participants were primarily Caucasian with an average age of 23.9 years. The minimum age was 21 and the maximum age was 36. The majority of participants were female (females n=19, males n=13). Of the participants, 12 were emmetropic and 21 were contact lens corrected at the time of the study. Visual acuity was measured using a standard Snellen acuity chart with the participant standing at a distance of 20 feet. Monocular acuities were taken of all participants. Visual acuities of both the right eye and left eyes were 75% 20/20 (n=48) and 25% 20/20-1 (n=16). Ocular dominance was determined using the "hole in the hand" method, and revealed that 78.13% participants were right eye dominant (n=25) and 21.87% were left eye dominant (n=7). All participants had full confrontational fields (n=32).



With the device powered off, each participant underwent a central 30-2 SITA-Fast visual field test for the right eye using the Humphrey Visual Field Analyzer (Carl Zeiss Meditec). All study participants were first-time Google Glass wearers, had previously performed visual field testing, but had no history of visual field defects in either eye. Visual field defects were determined using the Pattern Deviation values.

RESULTS:

Visual field analysis demonstrated relative scotomas in 75% (n=24) of the participants in the superotemporal quadrant. Participants displayed an average of 1.65% false positive errors (minimum 0%, maximum 13%), 0.625% false negative errors (minimum 0%, maximum 7%), and 0.22% fixation losses (minimum 0%, maximum 100%). Average test duration was 5:56 (min. 5:13, max 6:42). Of the points with a defect within the superotemporal quadrant, 8% of those points have a p value <5%; 2.08% with a p value <2%; 1.56% with a p value <1%; and 2.43% have a p value of <0.5%. Overall, 14.06% of the superotemporal quadrant points were abnormal and 85.94% were normal.

Analyzing left eye dominant participants (n=7) alone , the percentage of normal points was 94.44% (5.56% missed total); 4.76% $p<5.0$, 0% $p<2.0$, 0.79% $p<1.0$, and 0% $p<0.05$. Right eye dominant participants (n=25) analyzed alone showed 83.56% normal points (16.44% missed total); 8.89% $p<5.0$; 2.67% $p<2.0$; 1.78% $p<1.0$; and 3.11% $p<0.05$. Two participants showed a 50% abnormal superotemporal quadrant, with 55% of those points within $p<0.05$.

DISCUSSION:

Only a handful of studies have analyzed visual function while wearing Google Glass and other head-mounted technology.[3] As with this study, their results are limited by the relatively small study sample size. If Google Glass or other similar technology is to be broadly marketed, a larger and more diverse study sample would be necessary in order to generalize our results to the national and global populations.

Our main concern for studying the bulky frame and the visually-obstructive screen of Google Glass was to assess any potential visual field restrictions. Any constrictions could be detrimental to activities of daily living, especially while driving on the road.[2] Scotomas in any quadrant have the potential to limit a driver's view of pedestrians, oncoming traffic, street signs, and traffic signals. The superior scotomas observed in this and similar studies would have a much more prominent effect on viewing street signs and traffic lights.

Although the results show 75% of the participants had at least one point in the superotemporal quadrant flagged as irregular, this is not an accurate representation of the relative scotomas present. With only 14.06% of the tested points showing some degree of defect, the Google Glass frame alone does not appear to be disruptive to the superotemporal field. Of the tested points showing an irregular field, the majority fell under $p<5.0$. Regarding the two participants who showed a 50% disrupted superotemporal field, the fitting of Google Glass is

much more variable than the fitting of a traditional spectacle frame, perhaps leading to variable position of the frame itself and causing a more obstructed field of these participants.

Ocular dominance did show mild differences in their respective results: right eye dominant participants showed a 11% reduction in normal points compared to left eye dominant participants. This data may be coincidental and not a significant difference between right or left ocular dominance, but could be something for future manufacturers and potential consumers to consider.

CONCLUSION:

Shortly after this study was underway, Google Inc. decided to discontinue the production of Google Glass.[4,5] Despite this obvious setback to the utility and applicability of these specific study results, we believe that this information will be useful to Google Inc. and other technology companies as they continue to create similar wearable technology. Although Google Glass was discontinued, the continued expansion and promotion of other wearable technologies is sure to keep consumers and optometrists alike busy with the possible side effects and so it is important to continue to research these types of devices.

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Subject Data Sheet

Subject ID# :_____ Gender : F M DOB : _____/_____/_____

Visual Correction : None (emmetropic) Spectacles Contact Lenses

V/A with correction (6m) OD: ___/___ OS: ___/___

Eye Dominance: OD OS Confrontations: OD: _____ OS: _____

Staple Visual Field Print Out Here