Biomedical Electro-Optics: Looking at the Eyes

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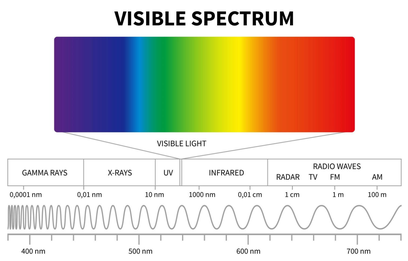
Introduction

The purpose of this work was to develop a baseline data set for **human eye metrics** across diverse participant demographics, which can be used in the development of an assessment tool for various clinical applications in neuroscience and human performance. In the case of concussion diagnosis, Pupillary Light Reflex can be used as a biomarker for concussion[1]. This work was performed in conjunction with a collaborative telehealth project with Premier Health.



Methods

Baseline pilot data was collected using a **Gazepoint GP3 Eye Tracker**. Participants were guided through a slideshow presentation on a computer screen while eye metrics data (pupil diameter, blink rate, gaze fixation) were recorded using Gazepoint UX analysis software.

- Participants were asked to complete a calibration exercise with the UX software prior to collecting data.
- Optical response time was measured by recording the time delay between a spot changing positions and the participant moving their eye fixation to the new spot. The spot returned to screen center after each trial.
- Pupil size was measured by the software. The eyes were given 10 seconds to adjust between exposures to various wavelengths of light.
- The color that was viewed most was analyzed using a heat map utility and opacity maps of a color wheel.
- Participants were asked to complete a post-experiment survey regarding their age, eye color, any vision impairments, and whether or not they have had a concussion in the past.

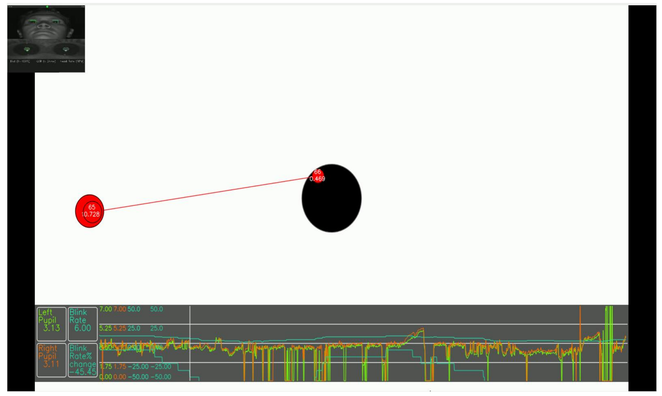
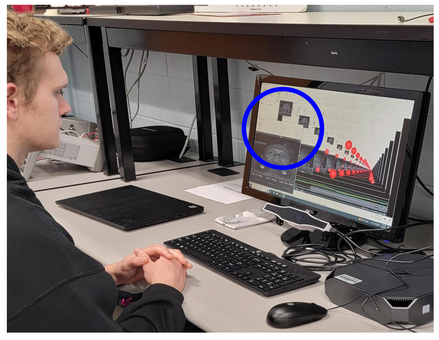


Figure 1: Fixation in Response to Moving Stimulus



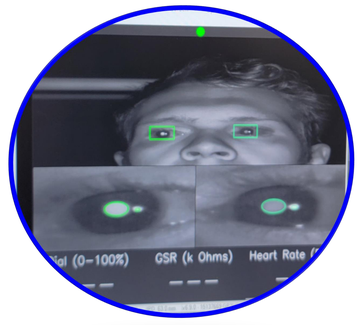


Figure 2: Experimental Setup

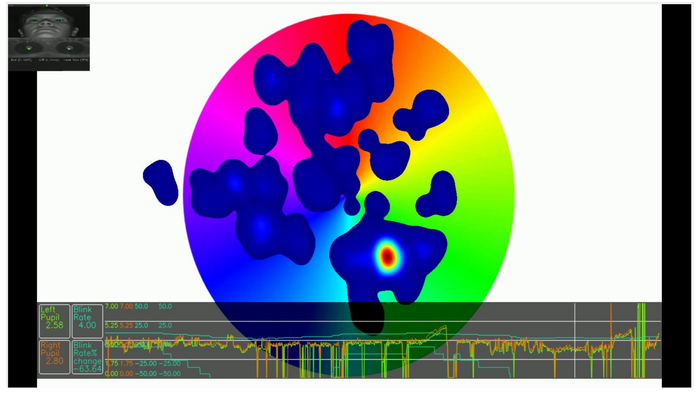
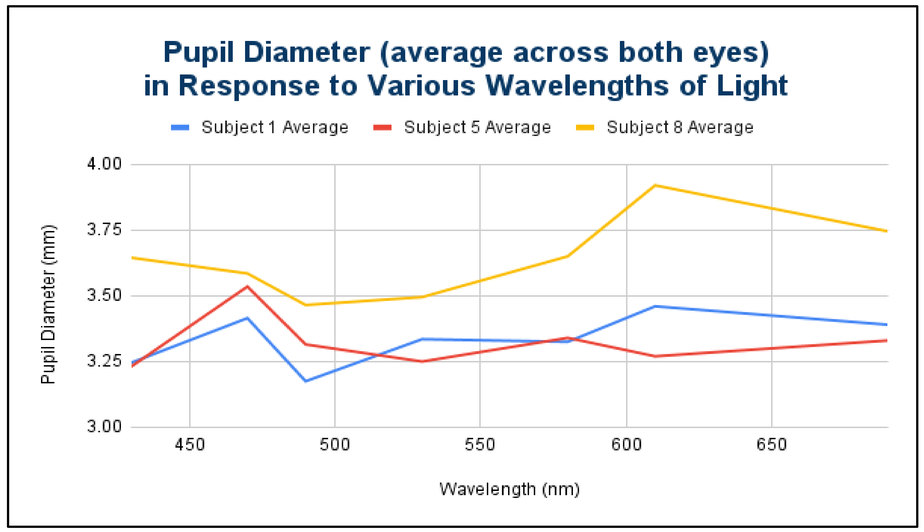


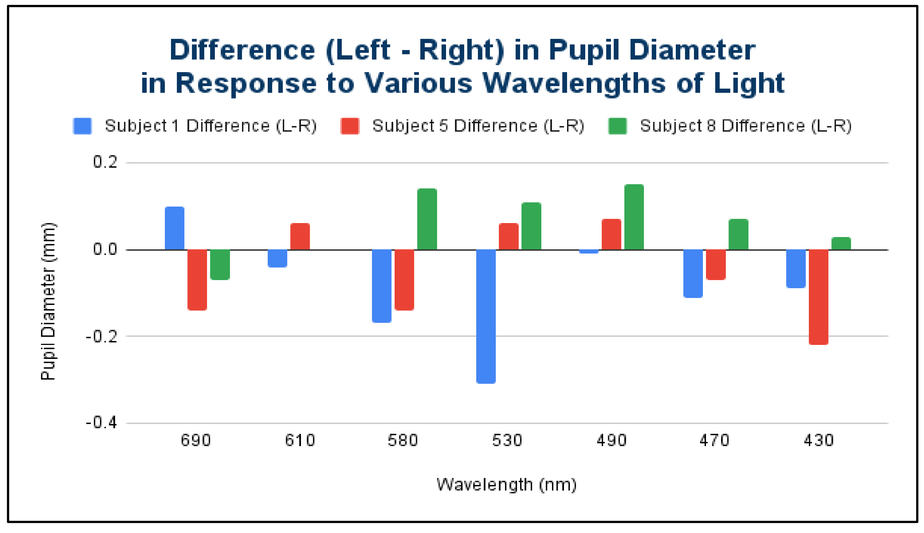
Figure 3: Heat Map Visualization of Color Wheel

References:
[1] https://doi.org/10.3390/life11101104

Results



- Variations in pupil diameter were observed between the left and right eyes across all participants for all wavelengths of light.
- The **smallest difference** between the left and right eyes was observed at a wavelength of 610 nm (orange) for all 3 subjects.
- The **greatest difference** between the left and right eyes was observed at a wavelength of 530 nm (green), average across 3 subjects.
- The time delay for following the spot was shorter when the spot returned to the center than when the spot initially moved.
- There were no signification interactions corresponding to eye color or concussion status. Subject 5 noted previous concussions 2 & 4 years ago.
- The favorite color of the participant had minimal effect on the color they viewed the most in the color wheel.



Conclusions

- A difference between left and right pupil diameters was observed for all subjects, indicating the importance of individual calibration prior to the use of pupil dilation information in a concussion diagnostic tool.
- Pupillary Light Reflex data may offer insight about wavelengths of light that improve (610 nm) or degrade (530 nm) vision performance.
- A larger sample size is required for detailed analysis of signification interactions such as age and gender.