Dynamic Extraocular Filtering: A Novel Method for Active Correction of Color Vision Deficiency, Validated With Steady-State Visual Evoked Potentials

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Color Vision Deficiency affects over 400 million people around the world, making it one of the most common genetic disabilities. There is currently no cure, prompting a need for an effective, non-invasive method to improve color contrast perception for Color Vision Deficient. In previous years, my research introduced a novel method of correcting contrast perception based on Differential Dynamic Illumination. While successful, this method had limitations, demanding the need for a more universal approach. This study proposes a novel correction method, based on actively controlling the wavelength spectrum that reaches the retinal photoreceptors. To verify the effectiveness of the proposed method, two phases of lab testing were conducted on a Color Vision Deficient subject with severe Deuteranopia. In the first phase, color contrast recognition rates were measured and calculated using randomized Standard Ishihara Test Plates. Results were analyzed using Fisher's Exact test. A statistically significant increase in color recognition was observed for modulation frequency of 15 Hz ($p=0.0104$), with a 100% recognition rate at frequencies 12 Hz or below ($p<0.0001$). In the second phase of testing, an EEG system was used to record Steady-State Visual Evoked Potentials (SSVEPs) from the Occipital Lobe in response to Red-Green chromatic stimuli with and without Dynamic Extraocular Filtering. Collected EEG spectra were analyzed to extract spectral density at stimulation frequency as a function of Red-Green balance in stimuli. Results confirm that the amplitude of SSVEP neural response increased with the application of Dynamic Extraocular Filtering, independently confirming increased color contrast perception.

Awards Won:
Second Award of $2,000