Ocular Dominance and Subjective Color Perception: A Study Using the Fechner-Benham Visual Illusion

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Knowledge to Go Places

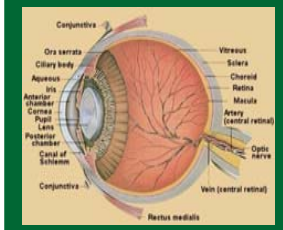
Introduction

Past research has demonstrated differences in visual processing between the dominant, or preferred eye, and the non-dominant, or less preferred eye. Researchers have accounted for these differences according to either physiological mechanisms (Porac & Coren, 1976) or behavioral preferences (Mapp, Ono, & Barbeito, 2003).

The behavioral preferences account can be eliminated by examining how the eyes process visual illusions which are not expected to be influenced by prior experiences. One particular illusion, the Fechner-Benham Color Illusion, involves disks featuring black and white designs which, when rotated, produce the illusion of various subjective colors within the disks (Rosenblum, Anderson, & Purple, 1981).

It was hypothesized that when viewing the Fechner-Benham Illusion with the non-dominant eye, participants would exhibit longer latencies for the onset of color and would report fewer colors compared to viewing with the dominant eye and with binocular vision.

The underlying physiological mechanisms that are often regarded in subjective color perception are either described high in the visual information hierarchy, in a neurophysiological site, thus eliminating the retinal level (Rhollec & Viénot, 1999; Robinson, 1896). Or, antagonistically, they are described as taking place within the retina in terms of an uneven distribution of photoreceptor cells (Jarvis, 1977).



Anatomy of the Retina

General Method

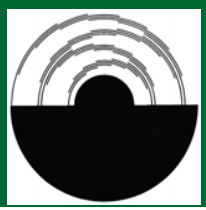
Participants (n = 29) were verbally presented with a Questionnaire in order to identify normal versus corrected vision, any injury that may affect visual acuity, and handedness. Participants' color vision was tested using the D-15 Panel Test for Color Perception.

Participants' ocular dominance was determined using the average of three tests: 1) a test of Motoric Efficiency, 2) a test for visual acuity using an eye chart, and 3) a test of ocular preference in tasks.

Design

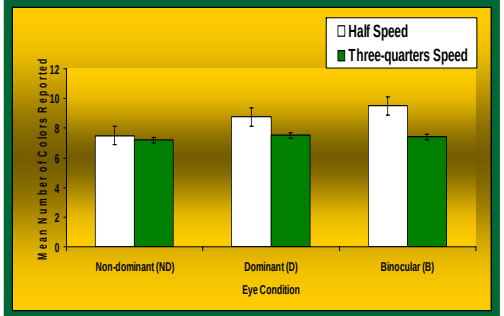
Participants were first presented with a control disk, in which objective colors could be observed. The disk was observed at ½ and ¾ full speed, under the three conditions, Non-Dominant, Dominant, and Binocular, which were randomized.

Participants then viewed the Fechner-Benham disks (2) at ½ and ¾ speeds, and under all three eye conditions.



Control Disk

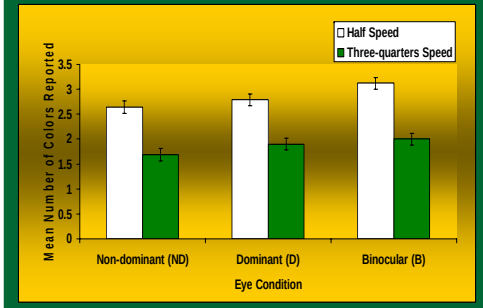
Number of Colors Reported



- There were no significant differences in the number of colors reported across the eye conditions for the control disk
- Significantly more colors were reported under half-speed compared to three-quarter speed viewing conditions for the dominant and binocular conditions

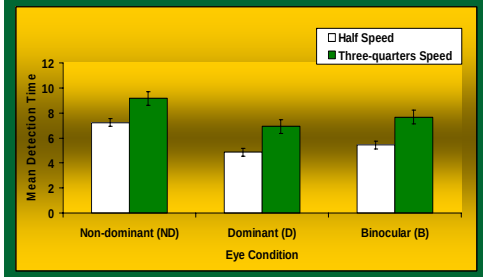
Fechner-Benham Disks

Number of Colors Reported



- Significantly more colors were reported across all the eye conditions under half-speed than three-quarter speed conditions
- Significantly less colors were reported under non-dominant eye viewing conditions than binocular viewing conditions under half-speed conditions (t = -3.31, p < .05)
- Significantly less colors were reported under non-dominant eye viewing conditions than binocular viewing conditions under three-quarter speed conditions (t = -1.86, p < .05)

Are there differences in the speed of onset of subjective colors across the eye conditions?

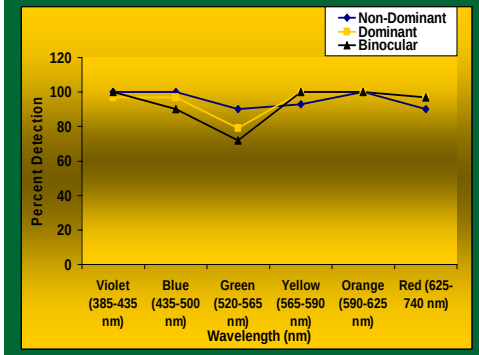


- Speed of color onset was significantly faster for the half-speed compared to the three-quarter speed conditions for the dominant (t = -2.01, p < .05) and binocular (t= -3.03, p < .05) eye conditions
- The onset of color in the non-dominant eye condition was significantly slower than the onset of color in the dominant eye condition in the half-speed condition (t = 3.78, p < .05)
- The onset of color in the non-dominant eye condition was significantly slower than the onset of color in the binocular eye condition in the half-speed condition (t = 2.62, p < .05)

How sensitive are the eye conditions to the spectral colors?

Spectral Colors

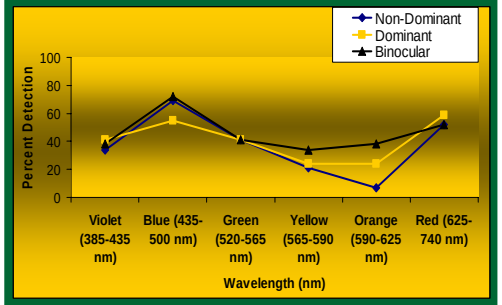
Control Condition Results: Wavelength Detection at 3/4 Speed



- The non-dominant eye condition is more sensitive to green than both the binocular and dominant eye conditions

How does color sensitivity change for subjective color perception?

Results For Experimental Conditions: Wavelength Detection at 3/4 Speed



- Overall, sensitivity to color is reduced when viewing the Fechner-Benham disks compared to the control disks
- The non-dominant eye is more sensitive to shorter wavelengths such as blue compared to the dominant eye
- The non-dominant eye condition is less sensitive to longer wavelengths such as orange compared to the dominant eye and binocular eye conditions

Conclusions

- When viewing the Fechner-Benham Color Illusion, the non-dominant eye reports significantly fewer colors compared to binocular vision
- When viewing the Fechner-Benham Color Illusion, the non-dominant eye requires significantly longer time for color onset compared to both the dominant eye and binocular vision
- When viewing the Fechner-Benham Color Illusion, the performance of the dominant eye in color perception is near equal to that of binocular vision
- No significant differences were found for the control conditions, thus suggesting that visual processing differences among the eye conditions are unique to subjective color processing
- Sensitivity to spectral colors changes across the control and experimental conditions

References

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Mapp, A.P., Ono, H., & Barbeito, R. (2003). What does the dominant eye dominate? *Perception and Psychophysics, 65,* 310-317.

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