COMPARATIVE STUDY OF THE EFFECTS OF BLUE AND GREEN FILTERS ON BINOCULAR AMPLITUDE OF ACCOMMODATION

BY

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ABSTRACT

The effects of blue and green filters on binocular amplitude of accommodation were compared. Fifty healthy emmetropic volunteers aged 20 to 30 (mean age 24.18±1.52) years were the study subjects. Binocular amplitude of accommodation was first measured through the 'no lens' situation using the push-up-to blur method to obtain the baseline value. The measurements were repeated through a pair of blue filters and green filters inserted separately into the trial frame. The analysis of variance at 0.05 level of significance was used to analyze the data. The Dunkad comparison test at 0.05 level of significance was further used to compare the effects of the variables. Results showed that the blue and green filters significantly decreased binocular amplitude (P = 1.84 and 2.74 respectively). There was no significant difference between the comparative effect of blue and green filters on binocular amplitude of accommodation. The importance of filters in achieving comfortable vision for the patient has further been highlighted, however, the choice of which filters to use between the blue and green filters would depend on patient preference.

KEYWORDS: *Amplitude of accommodation, Blue filters, Green filters, Eye strain, Visual stress.*

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INTRODUCTION

Optometric practice aims at providing both optimal and comfortable vision to a patient. According to the photochemist, the visual process consists of the absorption of light by a specialized molecule, visual purple or rhodopsin. The absorption of light provides the rhodopsin molecule with a supply of extra energy and it is said, in this state to be "activated"; in this activated state it is highly unstable and so it will change to a new form. The effects of this change will be to cause an 'excited' condition of the rod as a whole and it will be this excited condition that will ultimately lead to the sensation of light[1]. The visible spectrum constitutes a small portion of the electro-magnetic spectrum in the region between 10^{-4} to 10^{-5} (from approximately 390 to 760nm). Within the visible spectrum, radiation of all wavelengths is not equally visible[2]. The cones of the human eye are sensitive to three wavelength ranges which are interpreted by the eye as blue (narrow with a peak near 419nm), green (broader with a peak near 531nm) and red (also broad with a peak near 558nm which is naturally more like yellow). All colours seen by the visual system are a combination of relative intensities of the three wavelengths red, green and blue[3].

A spectral colour or hue has been idealistically defined as the sensation corresponding to a single wavelength. This definition is too rigid, both because of the limitations of discrimination of the human eye, and the experimental difficulty in obtaining light confined to a single wavelength. Thus coloured lights may be obtained by the use of filters, which cutoff many wavelengths and selectively transmit others, these filters are never sufficiently selective to confine the transmitted light to a single wavelength and at best they transmit a narrow band about a mean position[1]. Filters selectively absorb wavelengths to produce colours by subtraction[3]. Coloured glasses, cellophane, plastic and tinted lenses are examples of filters. Red filters absorb blue and green wavelengths allowing only red wavelengths to pass; green filters absorb blue and red wavelengths allowing only green wavelengths to pass, while blue filters absorb red and green wavelengths allowing only blue wavelengths to pass. A filter can greatly enhance the human eye's perception of details. Filters work by blocking a specific part of the colour spectrum, thus significantly enhancing the remaining wavelengths. The pupil of the human eye automatically dilates in response to a decrease in light level; accordingly, sunglasses will cause a certain amount of pupillary dilatation[4]. When the pupil dilates the lens automatically flattens and accommodation relaxes.

Accommodation is the process by means of which the optical system of the eye varies its focal length in response to visual stimuli. This process is mediated by the ciliary muscle and involves an increase in the vergence of light brought about by the crystalline lens[2]. The amplitude of accommodation is the maximum amount of accommodation that the visual and ocular system can produce[5]. The binocular amplitude of accommodation is higher than the monocular amplitude of accommodation, because convergence comes in to abet accommodation[2].

The prescription of tinted lenses to assist children and adults with reading difficulties is based on the theory that poor readers have the problem of excessive sensitivity of the retina to particular frequencies of the light spectrum[6]. Some researchers[6,7], described a syndrome of visual symptoms and distortion (visual perception, eye strain and headache) that can be alleviated with coloured filters or coloured cards. This syndrome has been referred to as 'scotopic sensitivity syndrome', or 'Irlen syndrome'; which later became known as 'Meares- Irlen syndrome' or visual stress[8]. Coloured overlays and tinted lenses are used to improve reading ability and visual perception, increase in sustained reading time and eliminate symptoms associated with reading such as light sensitivity, eyestrain, headaches, blurring of print, loss of place and watery eyes[9]. There is evidence that the underlying symptoms associated with the Irlen syndrome are related to identifiable vision anomalies like accommodative, binocular and ocular motor dysfunction in many patients seeking help from coloured lenses[8]. It has been established that coloured filters reduce visual stress and increase reading speed[10].

Coloured filters are a safe intervention for visual stress and have been widely used over the last fifteen years and the efficacy has been demonstrated[10]. This study therefore became pertinent to compare the effects of blue and green filters on binocular amplitude of accommodation, to determine if one offers greater relief than the other.

RESEARCH METHODOLOGY

Fifty healthy emmetropic volunteers aged 20-30 (mean age 24.18±1.52) years were the research subjects. These subjects were selected from Abia State University and the optometry clinic there was the study clinic. The subjects were selected irrespective of gender.

Proper case history and ophthalmoscopy were carried out to ensure good ocular and systemic health. The binocular amplitude of accommodation of each subject was measured without lenses to obtain the baseline value using the push-up-to blue method[11]. The near point Snellen's card with 20/25 line of letters held at 33cm at the first instance was used as target[5]. The near point card was gradually moved towards the subject who was instructed to look at the 20/25 line of letters with both eyes open. The distance at which the subject reported the first sustained blur was measured and the dioptric equivalence recorded as the binocular amplitude of accommodation. A pair of blue filters, and then a pair of green filters (British cyanine green) were inserted into the trial fame and binocular amplitude of accommodation measurements repeated separately through these filters, and appropriately recorded.

The analysis of variance (ANOVA) and Dunkad comparison test methods at 0.05 level of significance were the statistical tools used. Analyses of data were done to find out the effect of each variable on binocular amplitude of accommodation and also their comparative effects.

RESULTS

The mean baseline binocular amplitude of accommodation (A.A) was 13.12D. The mean binocular A.A, through the blue filters was 11.28D and that through the green filters was 10.38D.

Using the analysis of variance, the F-calculated, 27.92 was greater than the F-tabulated, 2.6.

Using the Dunkad comparison test to find out the effect of blue filters on binocular A. A., the value got, 1.84 did not fall within ±0.96. The value got for the effect of green filters on binocular A. A. was 2.74 which also did not fall within ±0.96. The comparative effect of blue and green filters on binocular A. A. gave the value 0.90 which fell within ±0.96.

DISCUSSION

Filters work by subtracting certain wavelengths from the spectrum. The individual and comparative effects of blue and green filters on binocular amplitude of accommodation were studied. A reduction in the binocular amplitude of accommodation from 13.12D to 11.28D and 10.38D for blue and green filters respectively, was observed. Using the analysis of variance (ANOVA) method at 0.05 level of significance, a significant difference was found between the 3 variables i.e. baseline or no lens situation, blue filters and green filters (F-cal, 27.92 > F-tab, 2.6). The Dunkad comparison test at 0.05 level of significance further confirmed the individual significant effects of blue and green filters on binocular amplitude of accommodation. However, there was no significant difference between the comparative effect of blue and green filters on binocular A. A. From the calculated variance (table 1) green filters had the least variance which meant that they had the most significant effect on binocular amplitude.

The results from this study agree with a study by Simmers[12], which stated that ocular accommodation was greater while viewing target in the 'no lens' position but reduced when tinted lenses were worn. This is because when there is no lens, the overall luminance of the target is greatest leading to the largest amplitude of response[13]. The reduction in binocular amplitude with filters maybe due to reduction in cortical hyper excitability. Tinted lenses reduce excessive sensitivity to the retina to particular frequencies of the light spectrum[6], which may subsequently lead to reduction in binocular amplitude.

Filters work by blocking a specific part of the visible spectrum, thus significantly enhancing the remaining wavelengths. The pupil of the human eye automatically dilates in response to a decrease in light level; accordingly, sunglasses will cause a certain amount of pupillary dilatation[4]. When the pupil dilates, the lens flattens leading to relaxation in accommodation.

The use of filters for more comfortable vision is further highlighted in this study; and since no significant difference was found between blue and green filters the choice of filters would depend on patient's preference.

Table 1: Mean Binocular Amplitude of Accommodation (n = 50)

	Baseline (D)	Blue filters (D)	Green filters (D)
Sum	656.20	564.00	519.15
Mean	13.12	11.28	10.38
Variance	6.22	3.94	2.61

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