DOI: 10.14260/jemds/2014/3353

ORIGINAL ARTICLE

COLOR VISION IN DIFFERENT INTENSITIES OF LIGHT

Venkatesh S[1], Puneeth M[2]

HOW TO CITE THIS ARTICLE:
Venkatesh S, Puneeth M. "Color Vision in different intensities of Light". Journal of Evolution of Medical and Dental Sciences 2014; Vol. 3, Issue 41, September 04; Page: 10408-10412, DOI: 10.14260/jemds/2014/3353

ABSTRACT: Color vision is the ability to make discriminations based on the wavelength composition of light. Intact color vision is mandatory for selection of posts related to driving, traffic services, railways and armed forces. Color perception may be influenced by a variety of factors of which intensity of ambient light is the most important. The optimum intensity of light for testing the color vision is not clearly defined. So there is a need to evaluate that optimum intensity of light to be used for carrying out color vision testing. **OBJECTIVE:** To evaluate the optimum intensity of light for testing color vision. **METHODOLOGY:** 90 subjects in the age group between 15-25 years are subjected to color vision testing using Ishihara's chart in different intensities of light in a dark room. The subjects are instructed to read the numbers or trace the lines in each plate of the book at different intensities of ambient light. The intensity at which the subject is able to perform best is noted and the data is statistically analyzed. **RESULTS:** The number of choices read incorrectly was more with illumination less than 60W and was statistically significant ($P < 0.05$). Color perception was found to be better at higher intensities of light-60W, 100W, 200W and in natural daylight and showed no significant difference. There were no statistically significant differences between males and females in color perception in different intensities of light. **CONCLUSION:** The intensity of light of carrying out color vision testing should not be less than 60W and natural day light is found to be ideal for color perception.

KEYWORDS: Color vision, light, intensity.

INTRODUCTION: The natural objects are visible because they reflect light. The proportion reflected varies with wave length, the surface reflectance and spectral power distribution of the illuminant reaching the eyes, to provide a reliable signal to the color of the surface. Humans have trichromatic colour vision, which involves three types of single cone receptors in the retina with maximum absorption at 430 nm, 530 nm and 560 nm which is commonly referred to as blue, green and red sensitive cones.

Color vision is an ability to make discriminations based on wave length composition of light and intensity,[1] which is perceived by a complex apparatus the eye and brain, color vision begins with activation of photo pigments in the cone photoreceptor cells.[2] Color sense serves an important purpose in animal kingdom and has evolved independently many times and serves many purposes such as reproduction and camouflage in some animals.

The act of seeing begins with the capture of images focused by the cornea and lens upon the light sensitive membrane, the retina which acts as a transducer which converts the patterns of light energy to neuronal signals.[3] This requires good ambient lighting conditions and is directly influenced by the intensity and amount of ambient light luminance which falls upon an object,[4] which resolves the power of the eyes to perceive the details and contours of an object which has to be perceived by the eye.[5]

DOI: 10.14260/jemds/2014/3353

This function is taken by the 5 million cones present in the human which function under day light conditions (Photopic) retina. Humans have well developed colour vision in lighted conditions however seldom have good colour perception in dim light. Mutations of the red and green pigments cause congenital x-linked color blindness in 8% of males.[2]

Tests for intactness of colour vision is performed routinely as a part of job recruitments and intactness of colour vision is mandatory for driving, traffic services, railways, armed forces etc., and colour perception may be influenced by variety of factors of which intensity of ambient light is necessary. This study was undertaken to evaluate the lowest light intensities or threshold required for colour perception and discriminate between colors.

OBJECTIVE: To evaluate the optimum intensity of light to carry out color vision test.

MATERIALS AND METHODS: A comparative study comprising 90 literate subjects of both the genders 45 each in the age group of 15-25 years who act as controls in daylight and cases in 6 different intensities of light, a detailed eye examination and health and vision status was evaluated and those with history of acute or chronic ocular causes, H/O optic neuritis, bilateral strokes and infarcts and those with history of self or in family of color blindness, glaucoma, hypertension and diabetes were excluded.

A written informed consent was taken and color vision was measured by using ishihara charts in bright day light(control) and in enclosed room with controlled light at different intensities- 15W, 25W, 40W, 60W, 100W, 200W and the luminous levels were chosen to be appropriate by using incandescent light in a dark enclosed room. The number of ishihara plates read correctly at different intensity of light and day light was statistically analyzed.

STATISTICAL ANALYSIS: Statistical measures such as Mean, Standard deviation, percentages and ANOVA were implicated to describe and analyse the data. $P < 0.05$ considered significant.

RESULTS:

Intensity of light	No. of plates read correctly (Mean±SD)	P value
Daylight	24	Control
At 15W	23.6±0.49	<0.01**
At 25W	23.87±0.43	0.048*
At 40W	23.87±0.35	0.019*
At 60W	23.96±0.18	0.16
At 100W	23.96±0.18	0.16
At 200 W	23.96±0.18	0.16

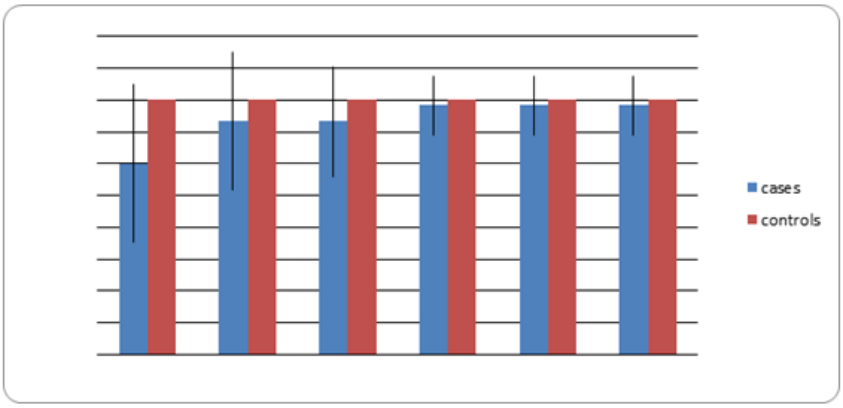
Table 1: Comparison of plates read in natural daylight with that at different light intensities

* Moderately significant (P value: $0.01<P \leq 0.05$)

** Strongly significant (P value: $P \leq 0.01$)

DOI: 10.14260/jemds/2014/3353

Graph 1: Comparison of plates read in natural daylight with that at different light intensities.

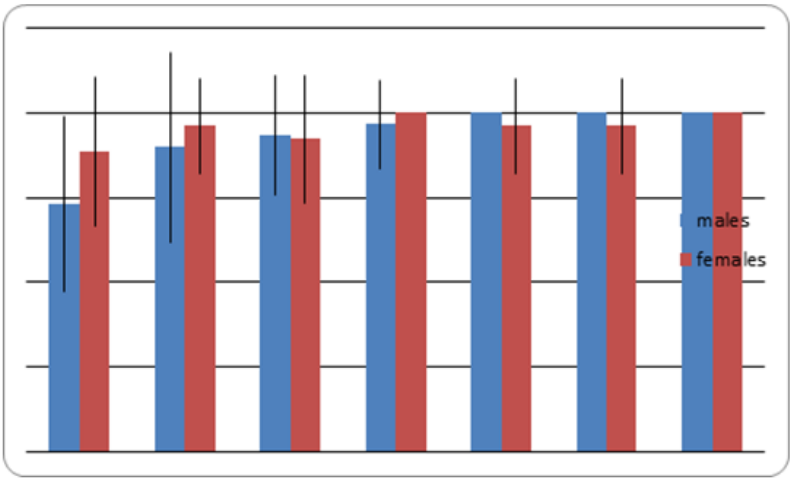


Graph 1

Light Intensity	Males (Mean±SD)	Females (Mean±SD)	P value
Daylight	24	24	1
At 15W	23.47±0.52	23.77±0.44	0.054
At 25W	23.8±0.56	23.92±0.27	0.23
At 40W	23.87±0.35	23.85±0.37	0.44
At 60W	23.93±0.26	24	0.18
At 100W	24	23.92±0.27	0.14
At 200 W	24	23.92±0.27	0.14

Table 2: Comparison of colour vision in day light with different intensity of light between males and females

Graph 2: Comparison of colour vision in day light with different intensity of light between males and females.



Graph 2

The number of choices read incorrectly was more with illumination less than 60W and was statistically significant (P<0.05). Color perception was found to be better at higher intensities of light- 60W, 100W, 200W and in natural daylight and showed no significant difference. There was no statistically significant difference between males and females in color perception in different intensities of light.

DISCUSSION: Retina acts as a transducer to convert light energy to neuronal signals and which is directly proportional to luminance. The cones function under photopic condition and cone system is specialized for color perception and eye spatial resolution.[2]

Light sensitive photo receptors cones hyperpolarize in response to light and these cells translate the visual image impinging upon the retina into continuous action potentials which propagates along the optic pathway to the visual centers within the brain.[3]

CONCLUSION: The intensity of light of carrying out color vision testing should not be less than 60W and natural day light is found to be ideal for color perception.

LIMITATIONS OF THE STUDY: Color vision is associated with intensity of light however regulation of the amount of light that enters varies with the size of pupil that is constricted in bright light and dilates in dim light as the photoreceptors get bleached out by too much light. [6]

Hence the limitations of this study are to further see at what luminance the bleaching of photoreceptors occurs and to define the suitable range of intensity of light for better color perception.

REFERENCES:

1. Karen K. DeValois and Michael A. Webster (2011), Scholarpedia, 6(4):3073.
2. Available at URL:doi:10.4249/scholarpedia.3073, accessed on 30/7/2013.
3. Widmaier EP, Raff H, Strang KT. Vander, Sherman and Luciano's Human Physiology. 9thed. Mc Graw Hill Publisher; 2004. Chapter 7, P.228.
4. Fauci, Braunwald, Kasper, Longo Hauser, Jameson, Loscalzo. Harrison's principles of internal medicine. 17th ed. Mc Graw Hill Publisher; 2008. Vol 1. Chapter 29, P.180-81.
5. Douglas G, Nicol F, Robertson C. Macleods clinical examination. 12th ed. Churchill Livingstone; 2009. P.318.
6. Godnig EC. Visual acuity under various illuminance lighting conditions. Optom Vis Sci . 2004 Sept-Oct; 20 (5):484-488.
7. Germann WJ,Stanfield CL. Principles of Human Physiology. 2nd ed. Pearson Benjamin Cummings;2005. Chapter 11, P.325.

DOI: 10.14260/jemds/2014/3353

ORIGINAL ARTICLE

AUTHORS:

1. Venkatesh S.
2. Puneeth M.

PARTICULARS OF CONTRIBUTORS:

1. Associate Professor, Department of Physiology, Bangalore Medical College and Research Institute.
2. Post Graduate, Department of Physiology, Bangalore Medical College and Research Institute.

NAME ADDRESS EMAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Venkatesh S,
Associate Professor,
Department of Physiology,
Bangalore Medical College and
Research Institute.
Email: venkie1971@rediffmail.com

Date of Submission: 19/08/2014.
Date of Peer Review: 20/08/2014.
Date of Acceptance: 25/08/2014.
Date of Publishing: 04/09/2014.