



L V Prasad Eye Institute
L V Prasad Marg, Banjara Hills
Hyderabad, INDIA

Meera & L B Deshpande
Centre for Sight Enhancement

&

Dr P R K Prasad Centre
for Rehabilitation of
Blind and Visually Impaired



**World Health
Organization**

Collaborating Centre for
Prevention of Blindness

Contents

- **Importance of color vision**
- **Inherited Color Vision Deficiency**
- **Acquired Color Vision Deficiencies**
- **Eye diseases that cause color vision deficiency**
- **Clinical Color Vision Tests**
- **Management of color vision deficiency**
- **Case Study**

Importance of color vision

Color vision is an essential part of everyday life, regardless of one's age. Color plays a crucial role in determining how children respond to objects around them – toys, food, and other environmental factors. In school, color plays an important role in art and science and, later, in the choice of clothes, accessories, furniture, cars, etc. Traffic signals are linked to color: green for go, red for stop, etc.

In almost every job like driving, maritime navigation, flying, police, photography, jewelry, tailoring, medicine, and painting, color vision is essential for effective functioning. A better understanding of how we perceive color and light can help us understand various conditions of visual impairment where color perception is compromised.

Light is an electromagnetic radiation, which is a mixture of different wavelengths. The wavelength within the human visibility range (approx. 380 nm to 740 nm) is called light. Surfaces that reflect all the wavelengths appear white and surfaces that absorb all the wavelengths appear black. The retina contains three different types of color receptor cells or cones. They are:

- S cones – short wavelength cones or blue cones, which are more sensitive to light and are perceived as blue,
- L cones – long wavelength cones or red cones, which are more sensitive to light and are perceived as red, and
- M cones – middle wavelength cones or green cones, which are more sensitive to light and are perceived as green.

The term 'color blindness' is a common but misleading term that implies total loss of color vision. In most cases the defect is only partial and a better term to describe it would be 'color vision deficiency'. Color vision deficiency occurs due to the absence of one or more types of color receptors.

For persons with visual impairment, identifying details is often a problem; if they also have color vision deficiency it becomes even more difficult for them to differentiate between colors and see details in objects.

Color vision deficiency is classified according to the primary cause; it may be congenital (inherited) or acquired.

Inherited Color Vision Deficiency

Congenital color vision defects are not associated with any pathology and patients do not have any signs and symptoms. The severity and type of deficiency is always the same in both the eyes. The deficiencies are further classified based on the minimum number of primary colors used to match perceived colors.

I. Trichromatism

- Normal trichromacy: All colors are matched with a mixture of primary colors.
- Anomalous trichromacy: Three primary colors are used in a mixture – a different intensity of each primary color is used.
 1. Protanomaly (weak red); 2. Deuteranomaly (weak green); 3. Tritanomaly (weak blue)

II. Dichromatism

Two primary colors are used to match any perceived color

1. Protanopia – lack of the L cone photo pigment
2. Deutanopia – lack of the M cone photo pigment
3. Tritanopia – lack of the S cone photo pigment

III. Monochromatism

A color is matched by adjusting the intensity of another color; all colors of the visible spectrum are seen as grays of differing brightness.

1. Rod monochromacy (typical achromatopsia)
2. Cone monochromacy (atypical achromatopsia)

These color vision deficiencies have either autosomal or X-linked inheritance. The inheritance of red-green defects are also X-linked, blue-yellow defects are autosomal dominant and achromatopsia autosomal recessive.

Acquired Color Vision Deficiencies

These deficiencies are associated with a disease, toxicity or trauma (see box). The severity varies according to the severity of the disease and could vary for each eye. There are three different types of acquired defects: Type I red-green defects, Type II red-green defects and Type III blue-yellow defects. The most commonly seen defect is blue-yellow.

These images examples show how a person with color vision deficiency perceives the world.



Eye diseases that cause color vision deficiency

Red-green deficiency

- Optic neuritis
- Papillitis
- Leber's optic atrophy
- Lesions of optic nerve and pathway
- Heredo-macular degeneration
- Fundus flavimaculatus

Blue-yellow deficiency

- Glaucoma
- Diabetes
- Retinal detachment
- Chorioretinitis
- Papilloedema

Drugs that cause color vision deficiency

Red-green deficiency

- Antidiabetic drugs (oral)
- Tuberculosis

Blue-yellow deficiency

- Erythromycin
- Chloroquine derivatives
- Indomethacin

Red-green and/or blue-yellow deficiency

- Ethanol
- Digitalis
- Oral contraceptives

Clinical Color Vision Tests

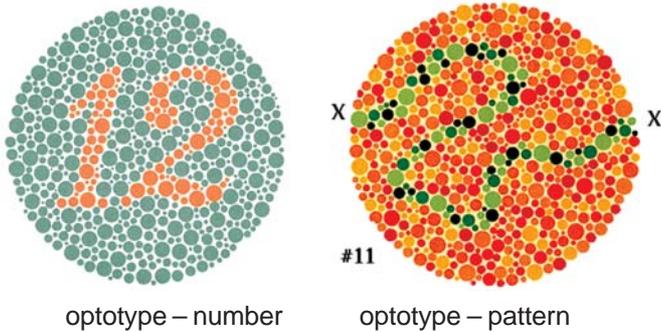
Color vision tests are used to screen patients and diagnose the type of deficiency and its severity, and to assess the significance of the deficiency in a particular profession, vocation or occupation.

The different types of clinical color vision tests used are:

- Pseudoisochromatic plate tests
- Arrangement tests
- Matching tests
- Naming tests

Pseudoisochromatic plate tests

These involve an object in which a pattern is delineated by a color difference against a background of the same luminous reflectance. The optotype can be a number, letter, symbol or pattern.



Commonly available pseudoisochromatic tests are Ishihara's test, American Optical Hardy-Rand-Rittler Plates, standard pseudoisochromatic plates and Color Vision Testing Made Easy.

Ishihara's test

Ishihara's test was developed in 1906 and was the first pseudoisochromatic test to be commercially produced. The test consists of different kinds of plates. The **demonstration plate** is for the purpose of instruction, and can be identified by a person with color vision deficiency. **Disappearing plates** cannot be detected by people with color vision deficiency. **Alternative plates** elicit an alternative response for those with color vision deficiency, while **hidden plates** are only visible to persons with color vision deficiency. **Diagnostic plates** are those in which two figures are used to distinguish between protans and deuterans.

Ishihara's test is considered to be a gold standard for rapid identification of red-green deficiencies. This is a screening test, in which normal subjects may sometimes fail and mild deuterans may pass.

Arrangement tests

In this type of test the colors of different hues have to be arranged in a specific order. The tests available are Farnsworth Munsell 100 Hue Test, Farnsworth Munsell Dichotomous D-15 or Panel D-15 Test, L'Anthony Desaturated D-15 test and H-16 test.

Matching tests

In this type of test one color is to be matched mixing two colors, e.g., the Nagel anomaloscope. The other commercially available tests are City University Test and Intersociety Color Council Color Matching Aptitude Test.

Naming tests

These tests are used in occupational situations such as driving, marine navigation, flying, etc. for example, the Farnsworth Lantern and the Holmes-Wright Lantern.

Farnsworth Munsell Dichotomous D-15

This consists of one reference disc and 15 numbered colored discs with different hues. The discs have to be arranged in a sequence starting with the closest match to the reference cap. The numbers of the discs are then joined using straight lines on a scorecard. The pattern of the lines helps diagnose the type of deficiency.

This test is a powerful tool for differentiating between subjects with color vision deficiency and those who are normal or mildly color deficient.

Management of color vision deficiency

There is no treatment for color vision deficiency. However, it can be dealt with through alternative measures.

Counseling

Most people with congenital color vision deficiency do not know that they cannot identify certain colors. They come to know of their condition when they have an eye examination or when they fail to get placements in certain professions. However, persons who have acquired color vision deficiency find it difficult to adapt to the change in their visual ability. Hence, they should be counseled about their deficiency and how to overcome it.

Tactile clues

Visually impaired patients usually use other cues to identify details. For those with additional problems of color vision deficiency, tactile clues may help. For example, if buttons of the same contour are stitched to a pair of clothes it becomes easy to match the garments.

Labels

To enable students to identify color pencils, each pencil should be labeled with its color. Similarly, the colors of figures in books should be labeled so that students know which color to use while drawing.

Design/Pattern clues

In normal maps places are differentiated by colors. For students with color vision deficiency places must be marked on the basis of different patterns or designs, instead of colors.

Arrangements and positions

Furniture and objects at home or in the office should be arranged in a specific order so that patients can identify them even though they cannot differentiate between certain colors.

When dealing with persons with visual impairment, it is important for professionals to keep in mind the possibility of color vision deficiency and take appropriate diagnostic and rehabilitative measures.

Greeting cards designed by children with visual impairment are available for sale. Please contact Vision Rehabilitation Centres, LVPEI.

Case Study

Jayanthi*, a 4-year-old girl, was diagnosed to have Rod Monochromatism in both the eyes. This condition does not have any surgical or medical treatment and leads to low vision. A clinical examination revealed that in addition to low vision she also had color vision deficiency.



Jayanthi performing the Farnsworth D-15 test

At kindergarten school Jayanthi could not identify different colors while drawing. So her mother brought her to the Centre for Sight Enhancement at L V Prasad Eye Institute. Jayanthi and her mother were given various suggestions to overcome the problem, which included:

1. Labeling crayons and color pencils with the first alphabet of each color such as 'R' for red, 'B' for blue, and so on. These alphabets were written in large print to enable Jayanthi to read them easily.
2. Jayanthi's teacher was advised to label diagrams such as an apple with a label 'red' indicating that red color was to be used to color the diagram.
3. Jayanthi's mother was advised to sew buttons of similar contours on the inside of a pair of clothes, to indicate that they are matching. For example, a blouse and a matching skirt.
4. The teacher was advised to mark places on maps with different patterns instead of colors for Jayanthi.

(*Name changed to protect privacy)

Alumni Brainstorming Meet

The Vision Rehabilitation Centres conducted a low vision alumni brainstorming meet to assess the impact of low vision training programs. Representative members of LVPEI's low vision alumni participated enthusiastically in the workshop, with constructive suggestions for increasing the range and scope of the work of low vision professionals. The 22 alumni were chosen from all regions, based on their performance. Faculty members of LVPEI were also present.

The areas covered during the brainstorming meet were:

- Barriers for utilization of skills learnt in the training program
- Suggestions for changes/inclusions in the short-term program and Low Vision Awareness Program (LAP)
- Setting up of an alumni support group
- Special session – discussion on difficult cases

Enrol now

A three-day **Low Vision Awareness Program (LAP)** for optometrists, ophthalmologists, rehabilitation professionals – preferably institution-based – is conducted in **March** and **September**.

The three-month **Short-term Fellowship Program in Low Vision Care** for optometrists and ophthalmologists begins in **January, April, July** and **October**.

Programs sponsored by Sir Ratan Tata Trust, Mumbai.

Dr Sarfaraz A Khan

sarfaraz@lvpei.org

You can help the Vision Rehabilitation Centres of L V Prasad Eye Institute in several areas, such as discovering basic causes and treatment strategies for eye disease through research, restoring the vision of a poor patient, or helping to expand the frontiers of ophthalmology.

Contributions to the Hyderabad Eye Institute or the Hyderabad Eye Research Foundation are tax deductible. Donations above Rs 250 are exempt under Section 80G of the Income Tax Act, 1961 for Hyderabad Eye Institute and under section 35(i) (ii) for Hyderabad Eye Research Foundation.

**You Can
Make A
Difference**

For more information please contact:

VISION REHABILITATION CENTRES

L V Prasad Eye Institute

L V Prasad Marg, Banjara Hills

Hyderabad 500 034, India

Ph: (091) 040 3061 2821, 2354 2790 Fax: (091) 040 2354 8271

email: sarfaraz@lvpei.org Web Site: www.lvpei.org



www.lvpei.org



Achieve. Anything. Anywhere.

www.spwebsite.com

This publication is supported by

SPSOFT

1-10-45, 46/1, Chikoti Gardens

Begumpet 500 016, A.P., India

Email: info@spwebsite.com

www.spwebsite.com