THE X-CHROM MANUAL
REVISITED
Harry I Zeltzer OD, DOS, FAAO, FVI

Dr Zeltzer graduated from the New England College of Optometry in 1952 and practiced in Waltham, Mass. for thirty five years. During that time he was a vision consultant to the Army Research Institute of Environmental Medicine, a component of Natick Laboratory as well as to the Helen Keller International Child Sight Program. In addition to general practice he specialized in treating color deficiency which culminated in the invention of the X-CHROM lens. Following his retirement in 1986 he mentored students attending eye care missions in developing countries. Realizing the inequity of world eye care was an incentive for him to cofound VOSH-ONE (Of New England). He furthered his commitment by joining the parent
organization, VOSH/International. In the past thirty years he served it in various capacities as webmaster, president, executive director and now as director emeritus. Dr. Zeltzer is the recipient of the Essilor UNESCO Award 2003, the Honorary Degree of Doctor of Ocular Science 2004 of the New England College of Optometry and the VOSH/International Lifetime Achievement Award 2008. He is Director Emeritus of Friends of ASAPROSAR (Salvadoran Rural Health), which he served for 20 years, is a Fellow of the American Academy of Optometry and a Fellow of VOSH/International. During WW11 he served in the Army of Occupation of Japan. Dr. Zeltzer is an Adjunct Professor at the New England College of Optometry and can be reached at harryizeltzer_alumni.neco.edu

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Introduction

I had an interesting color deficient patient who carried a red filter in his pocket to distinguish colored wires at work. Although his chief complaint was unrelated to color deficiency he expressed interest in something better than a filter. After working with the patient for several months I invented the X-CROM lens to improve color deficiency. The X-CROM manual provides comprehensive information about its development, the reason it improves color vision, why the visual system can tolerate a monocular red contact lens and how to prescribe it. Convenient forms pertaining to History, Genealogy, Q & A and Evaluation, which help make color deficiency more understandable, may be copied. The term “color deficiency” is preferable to “color blindness” since it is more accurate in describing the defect. Color deficient individuals partially cope with their deficiency by relying on external clues or asking others for help. It’s been my experience that many people with color deficiency would like an X-CROM lens if it were prescribed on a trial basis. In 2008 the name was rebranded to Zeltzer X-CROM to separate it from copies.

X-CROM IMPROVES:

1. Color identification
2. Color matching
3. Discernment of figures of a background (apples on a tree).

OF SPECIAL NOTE:

- The American Optometric Association confirms “Using special tinted eyeglasses or wearing a red tinted contact lens on one eye can increase some people's ability to
differentiate between colors, though nothing can make you truly see the deficient color."

http://www.aoa.org/patients-and-public/eye-and-vision-problems/glossary-of-eye-and-vision-conditions/color-deficiency?sso=y&ct=6668164b956d4facca29edaced83f9541fa6343f88f4cf54ae5b1e22fda02762938aa766e6ac361745830af57562fdoc4c8a4795362faddc52351685bf43b2dd

- The National Eye Institute conceded in 2015 “There is no cure for color blindness. However, people with red-green color blindness may be able to use a special set of lenses to help them perceive colors more accurately. These lenses can only be used outdoors under bright lighting conditions.” Facts About Color Blindness. 
  https://nei.nih.gov/health/color_blindness/facts_about

COLOR DEFI CIENCY AMONG OPTOMETRIC SPECIALTIES

- Color Deficiency
- Contact Lenses
- Geriatric (Nursing Home)
- Low Vision
- Neuro Ophthalmic Disorder (stroke, etc)
- Orthokeratology
- Ocular Pathology
- Ocular Nutrition
- Pediatric
- Sport Vision
- Vision Research
DEMOGRAPHICS AND EPIDEMIOLOGY

- **World population varies between 2-10% of males**
- **Ethnicity and indigenous background are a factor**
- **Caucasians are more likely to be color deficient**
- **USA population of color deficient among males is 7%**
- **USA population of color deficient among females is .05%**
- **USA number of color deficient males 10,000,000; color deficient females 800,000.**
Course Description

The X-CHROM® Lens Is a Monocular Contact Lens worn on the non dominant eye to Aid Color Deficiency.

WHAT TO DO?

- Screen every patient and screen monocular to rule out ocular disease.
- It can be shocking news if not detected in a previous eye examination.
- Ask every patient if color deficiency is in the family to predict the defect among relatives.
- Explain it as a generational defect gene to relieve guilt.
- Children should be tested before grade one.
- Ask parents to notify teachers.

Course Objectives

The course intends to raise awareness of color deficiency during a heightened technological era when color is of paramount importance. Hopefully, patients will not be dismissed, “It is not a serious problem. Many people have learned to live with it”.
The X-CHROM lens has been a solution for many color deficient patients since it was introduced in the late 1960s. Changes in design and material have improved wearability and appearance. The course provides basic information about prescribing the X-CHROM lens, its objectives an understanding of how color deficiency affects people, what steps to take in diagnosing the condition and how to prescribe the lens. Treating color vision deficiency is a rewarding experience that draws patients from a constant population. Each case is a subject of interest worth publishing. Included in the manual are forms used in practice for color deficiency.

**Monocular stimuli for a meaningful outcome**

A monocular contact lens filter for treating color deficiency had its root in my practice during the 1950s when I treated children with visual training. I found it intriguing how dissimilar images would rhythmically alternate and merge in a stereoscope. For example a stereogram of horizontal and vertical lines that would pulsate between right and left eye and then come together as a grid. For me it signified how adaptable a visual system is to dissimilar stimuli. Juxtaposing dissimilar images is not a conscious phenomenon until we see it stereoscopically or with an anaglyph. In 1957 I co-invented a game of checkers with coordinated colors and filters that required the patient to superimpose monocular stimuli. Creating a desirable outcome using dissimilar monocular stimuli relies on the plasticity of the visual centers in the brain. Another example of plasticity is when prescribing a monovision contact lens for presbyopia. Similarly the X-CHROM lens presents dissimilar stimuli to each eye, which is integrated so color vision becomes more meaningful. Throughout the manual “neuroplasticity of the visual system” is a term used to describe the power of the brain.
to adapt to a visual device or method if it serves a useful purpose.

Zeltzer, H.I. Visual Training With Interest N Eng J. Optometry, 149, Sept 1958
Characterizing Neuroplasticity

- Challenging the brain to function binocularly with anaglyphs or polarization.
- An incentive to overcome the obstacle of unequal colored images.
- A subconscious process that assimilates the sum of visual information into a meaningful interpretation.
- A neural process that overcomes a defect given a purpose and the tools for achievement.

Examples Of Neuroplasticity

- Monovision contact lenses for presbyopia.
- Low Vision devices that integrate magnification and visual field.
- Vision training with stereoscopic cards.
- Occlusion in amblyopia.
- X-CHROM Lens to change color confusion into recognizable values

Neuroplasticity: Teaching an Old Brain New Tricks
Dominick M. Maino, O.D., M.Ed. Illinois College of Optometry

“We have experienced a sea change in the understanding of neuroplasticity. Now, it is evident that we can take advantage of neuroplasticity to help correct many disorders of the visual system—-we, as clinicians, simply have to begin utilizing these treatment options for the benefit of our patients.”
History of Color Vision

Color And Its Use

A form of energy that’s all encompassing is one of the most useful tools for survival. Early man relied on color for safe travel, to forage berries, for seeding, harvest, and for hunting animals in the brush. Color in all its glory provides basic information about health and the integrity of our environment. Harmony in nature is represented by a multiplicity of vibrant hues. Decay is associated with gray and insipid tones. In technology and education it’s represented in color-coding and signals that ensure safety on land, sea and air. Color enriches our environment, bringing joy with passing seasons. It’s a language for artists who use it to create a feeling and emotion. It is also one of our finest diagnostic tools and foreboding when the body changes to red, green, yellow, and blue. Colors get exciting as the earth tilts from solstice and at noon when colors become brilliant. An infinite number of colors come from the visible light spectrum by altering hue, saturation and intensity.
Normal and Deficient Color Vision

Normal Color Vision

Trichromat or normal color vision is an uninterrupted appreciation of the spectrum from 380nm to 760nm without black, gray, or white areas. All those with normal color vision can differentiate between the six or seven hues of red, orange, yellow, green, blue, and violet. Any of these can be produced by mixing the three primary colors of red, green, and blue; thus, the reference to normal color vision as trichromacy. Trichromats are able to differentiate an infinite number of colors by varying hue, brightness, and saturation. The C.I.E. space (The International commission on Illumination) represents hues and
saturations at a constant luminance, which a trichromat sees except for the colors within the MacAdam ellipses. Among anomalous trichromats and dichromats the ellipses expand and coalesce thereby further reducing the number of colors in their visual spectrum.

THE C.I.E. COLOR SPACE (THE INTERNATIONAL COMMISSION ON ILLUMINATION)
Color Deficiency

A condition that causes colored objects to appear invisible, indistinguishable, and unidentifiable, that prevents young people on the threshold of a career from choosing an occupation, that unsuspectingly causes loss of job or transfer, that interferes with the educational process of a child, that blocks one from enjoying all of Mother Nature's wonders, is color deficiency. In varying degree, color deficient cannot identify the color of an object, recognize foreground from background, and compare colors.
Anomalous Trichromat and Dichromat

Abnormalities of color vision are classified as anomalous trichromat and the less common dichromat. The latter is more severe but less common, a consequence of missing one of the three types of photopigment. Anomalous trichromat can match colors with red, green, and blue stimuli but require more than the usual amount of one color. The dichromat having an absent color receptor uses two principal colors for matching the
spectrum. The defect is more easily classified with an anomaloscope.

1. **Deuteranomaly** is the most common defect (5%) with a manifested green weakness. Therefore, in matching a particular yellow, more than a normal amount of green is required with red.

2. **Protanomaly** is less common (1%) with a manifested red weakness. More than a normal amount of red is required with green to match a particular yellow.

3. **Tritanomaly** is atypical with a blue weakness. More than normal amounts of blue are required with green to match cyan.

**Dichromatism**

This is a form of moderate to severe color deficiency. Because of a missing cone receptor two types of functioning color receptors instead of three match all the colors in the brain.

1. **Deuteranopia** (erroneously called green blindness) is a form of complete red-green blindness. One afflicted sees neutral bands at two locations, blue green (497 nm) and outside of the spectrum, red purple. Incidence is 1% of male’s and .01% of females. Colors are 50% less bright. Blue and yellow appear normal. When neutral points are approached, saturation falls off until reds, greens, and grays are confused.

2. **Protanopia** (red blind) is a condition similar to deuteranopia. Blue, yellow, and gray are visible. There are two neutral bands and a substantial reduction of brightness. The most distinctive feature is shortening of the spectrum at 680 nm. No chromatic response can be evoked from this point to 760 nm, the normal limit. Maximum luminosity is at 540 nm, as compared to 560 nm
of the deuteranope. Incidence is 1% among males.

4. **Tritanopia** is atypical and manifested by reduced sensation at the short end of the spectrum.

**Acquired Color Deficiency**
This is usually due to ocular disease, toxins, or drugs. Kollner's rule suggests that disease of the optic nerve and visual pathway cause a red-green loss and disease of the retina and media cause a blue-yellow loss. The condition may remain masked if testing is binocular.

**Monochromacy**
Monochromatic or achromatic color vision is a rare condition No hues and saturations are appreciated. Color for this atypical group is a variation of grays and blacks; one stimulus will match all colors. There are two types. The rod monochromatic (.003%) usually has photophobia, nystagmus and poor vision. The cone monochromatic has normal visual acuity and is free of other symptoms except colorblindness.
In 1979 I prescribed a modified X-CHROM lens for both eyes to relieve a female patient of light dazzlement during the day and a monocular X-CHROM lens at night so that she could recognize the difference between red and green traffic signals when crossing the street.


Testing for Color Deficiency

Use of Color Deficiency Tests

Various pseudoisochromatic plates for adults and children are excellent for screening. Farnsworth D-15 determines the type and severity of the defect. A red paddle is useful to demonstrate figure and ground enhancement if contemplating an X-CHROM lens. The type of illumination will affect the results. Ideal testing is in natural daylight at high noon equivalent to 6500° Kelvin. A substitute for practical office use is a 15watt daylight fluorescent lamp. Testing distance is at the usual reading distance. For government and corporate requirements I recommend the Munsell 100 hue test and/or the RGB Anomaloscope. Test each eye for color vision defects to rule out ocular disease. Changes due to pathology anterior to the retina result in blue-yellow color defects, while posterior changes to the retina result in red-green defects (Kollner's Rule). Acquired color vision defects are usually the earliest sign of ocular pathology.
First X-CHROM Patient

In a typical eye exam the doctor strives for the best visual acuity but often ignores a significant population who are color deficient. Patients with color deficiency are told its not serious and something many live with. I became aware of the frustration of a color deficient male patient who happened to mention that he keeps a red filter in his pocket that he uses at work.
Joe a 25-year-old white male came to my office for a general eye exam. He carried a red filter in his pocket to decode colored resistors. He said the filter changed confused colors into light and dark tones. With the filter he knew the darkest wire was green, the medium tone wire was brown and the lightest wire was red. He had no difficulty seeing blue and yellow. He was always fearful of making a mistake. Occasionally he would ask a friend for help.

Joe exhibited deuteranomalous color vision, the most common type of color deficiency. I suggested that a monocular contact lens might give him the same results and possibly better than his pocket filter. I said that it hadn’t been done and if he was willing to come to my office occasionally for a few months I would try fitting him with a contact lens without charge. There was nothing in the exam that contraindicated the use of a contact lens so we proceeded without promise or expectation.

|challenge|making a filter contact lens for joe|
• Do no harm.
• Do not disturb the blue-yellow part of the spectrum that he normally sees.
• Do not reduce visual acuity with the contact lens to less than 20/40.
• Do not interfere with binocular vision.
• Do not interfere with eye dominancy.

Developing an X-CHROM Lens

Evolving Process from Filter to Contact Lens

• A filter that best separated color confusion into light and dark values for deuteranomalous is Wratten filter (red #25)
• Paragon Optical made the lens blanks equivalent to the Wratten filter but with enough light transmission so visual acuity is not less than 20/40
• Spectrum System of Waltham provided spectrophotometry
• Young Contact Lens Laboratory of Boston fabricated the initial contact lens.
• Art Optical https://www.artoptical.com/lenses/specialty-gp-lenses/special-lens-options/x-chrom/ makes the hard lens
• Adventure in Colors http://www.techcolors.com/ makes the soft lens
Joe reported a vast improvement over his pocket filter:

- He preferred wearing it on his non-dominant eye.
- Visual acuity of 20/20 was reduced to 20/30.
- He could determine the difference between red, brown and green resistors.
- Initially he described new colors that “jumped out” due to the Pulfrich Phenomenon that in days became marginal.
- Color identification improvement.
- Color matching improvement.
- Figure and ground improvement.

Overview of the X-CHROM Lens

The X-CHROM Lens is a monocular contact for the most common color deficiency that provides clues, which transform confusions into new values. Objects that previously blended with a background stand out. Matching articles of laundry and clothing is more easily accomplished. Electronic technicians can decode
resistors, mothers can monitor a rash, pathologists can evaluate slides, drivers can quickly notice a brake light, and bakers know when bread is browned.

**When to prescribe X-CHROM**

- Is there a mild red-green color deficiency?
- Is there a motivation and need?
- Is there good binocular vision?
- Is there an absence of ocular pathology?
- Can the patient wear a contact lens?
- Will the patient’s visual acuity be reduced to not less than 20/40

**Time Saving Approach**

- A complete eye exam.
- A color vision analysis using the included forms.
- Fitting a trial lens on the non-dominant eye
- Maintaining good visual acuity (at least 20/40).
- I recommend fitting X-CHROM in two or three visits
- If the patient does not demonstrate substantial color vision improvement at the beginning most likely the patient is a dichromat and case should be discontinued.
- Otherwise proceed in the same manner as with any other contact lens patients.

**X-CHROM is made as a Soft and Hard lens**

![Image of Zeltzer X-Chrom lens](image镇政府)
Adventure in Colors manufactures the pupil area so a specific wavelength is transmitted. The filter is usually 6 mm in diameter that minimally intrudes on the color of the iris. The remaining lens is clear. The recommended overall lens diameter is 14.5 mm, and the power is made according to the prescription. It can be made from a patient’s clear soft lens or be ordered with the 8.6 standard base curve. The success in fitting the lens is furthered by using a trial lens from a fitting set. Art Optical continues to make the rigid or hard lens after thirty years. The lens is prescribed at optometry school clinics, eye hospitals and private practices. The name was changed to Zeltzer X-CHROM because it was copied in the USA and other countries with having the same standards.

Outline of Recommended Procedure for the X-CHROM Lens

(1st Visit) Evaluation Examination

- Complete eye exam
- Take history of color vision, needs, problems, confusions, etc.
- Trace and project family color defects.
- Test and diagnose color defect.
- Determine feasibility of X-CHROM Lens for occupational and daily use.
- Select non-dominant eye for X-CHROM Lens.
- Determine trial lens parameters.
- Compensate (+. 25) for chromatic aberration.

(2nd Visit) X-CHROM Application

- Dispense the X-CHROM Lens for the non-dominant eye.
- Test visual acuity and binocular vision.
• Refract with lens in place for best visual acuity.
• Present inside color vision tasks.
• Call attention to fluorescence and vibrancy of color as temporary.
• Determine enthusiasm level of patient after an outdoor visual experience such as visiting a supermarket and clothing stores.
• Encourage patients to continue only if there is a significant improvement.
• Follow up as with other contact lens patients.

**Use of Color Filters**

*Generally speaking how should filters be used?*
Identification of colors by colored deficient persons is improved by use of one or more color filters. When a color is observed alternately with and without a filter or through different filters, color deficient learn to discern the changes in brightness saturation and hue. A red tinted lens and others will change a myriad of colors so that some will appear darker than others, emphasizing a difference. To carry it one step further, if the red lens is used by a person who is color deficient and he is viewing colored objects having red and green, the green portion will look darker than the red portion, so that what previously blended now becomes distinctly two portions or two colors. Another example is viewing brown and green through a red lens. The person who is deficient would usually confuse the two colors, but with the red lens, the brown is lighter than the green and the two colors then are separately distinctive.

*When you use a red filter, is it for one eye or both?*
The red filter is used for one eye. It separates the confusion of colors in the red-green range of the spectrum. If its used on both eyes it interferes with the appreciation of the blue-
yellow range of the spectrum.

In view of what you have said, is it possible to have a pair of spectacles in which you have one clear and one tinted red lens and would that be of any help to the color blind?

No. It has annoying reflections depending on the angle of light from the sun. Intervening light that surrounds eyeglasses is distracting. Light transmission control is more effective with a contact lens.

Is a diagnostic lens available?

Yes. Having a plano X-CHROM trial lens on hand is convenient if you plan on treating color deficiency.

Special Use of Color Filters Underwater

It is common knowledge that without artificial light the human eye is blind to colors underwater. As one descends in the water red is readily absorbed within the first and gradually, in the order of the light spectrum, other colors are absorbed, blue being the last at 60 feet.
In the late 1960s, I developed a bi-filter facemask for Voit Sporting Company that improved figure and ground contrast. The upper half is clear and the lower half yellow. Slight tilting of the head and alternate gazing improved contrast of color at various depths. It was later studied at the US Naval Submarine Base in Groton CT. Report # 679 US Naval Submarine Medical Center by S.M. Luria (cc)
Inheritance of Color Deficiency

An interest in color deficiency has raised many questions about heredity and the importance of anticipating a genetic defect. Knowing if it’s present, will alert parents and teachers who can then monitor a child’s development in education and choice of career.

Each adult cell contains 22 pairs of autosomes plus a pair of sex chromosomes, either an XX or XY pair. Male cells may be symbolized as 44A + XY and that of female cells as 44A + XX. The Y chromosome is inert, so that female cells have 46 functional chromosomes, and the male 45. The absence of one X chromosome containing hundreds of genes determines male and female characteristics. The absence of a functional mate to the X chromosome in males has some genetic consequences. Recessive genes or sex linked genes as in colorblindness and hemophilia will exert their effect. However in females, a dominant gene on the other X chromosome may mask these undesirable effects.

Examples of Inheritance

Illustrated are five examples in which the color deficiency is inherited with a male and female parent and four children, two of each sex.
CASE 1 when the male color deficient parent has daughters
and 100% of the daughters (Mary, Helen, Jane), become carriers. Cases 2,3,4,5 demonstrate the different scenarios exhibiting the defect.

CASE 2 in which Mary carries the recessive gene and 50% of the sons (Peter) are color deficient. And 50% of the daughters are carriers

CASE 3 illustrates the offspring of a female carrier and a color deficient male having a 50% chance of a carrier daughter, a 50% chance of a color deficient daughter, and a 50% chance of a color deficient son.

CASE 4 illustrates the offspring of a color deficient mother and a father without a defective gene resulting in a 100% chance of a color deficient son and 100% chance of a carrier daughter.

CASE 5 Illustrates both color deficient parents having 100% chance of male and female offspring color deficient.

Today if girls are found color sad
A rarity of extreme
Look to both mom and dad
Who have a recessive gene

Peter has two brothers and a sister who are yet to be examined. From the chart we learn that sister Dinah has a 50% chance of being a carrier and brothers Chris and Rusty have a 50% chance of exhibiting the defect.

Answers To Common Questions
On Color Deficiency

What is color blindness?
Color blindness is the common name for color deficiency. Color deficiency is the condition in which the number of colors and shades seen by an individual is less than normal. There are various degrees of color deficiency, ranging from mild difficulty in recognizing a few colors to an inability to recognize any colors.

How does a person with normal vision (trichromat) see color?
There are three visual color pigments in the cones of the retina that are sensitive to red, green, and blue. Each cone has a separate sensor so that different cones are stimulated by different wavelengths of light (colors). The cones react to the primary colors: red, green, and blue, and send messages to the brain which mixes them in appropriate proportions to provide normal color vision.

Can a trichromat have a color deficiency?
Yes. In fact, most who are red-green color deficient are trichromats that have a weak reception to one of the primary colors, mainly green.

What are the most common color deficiencies?
Red and green. In each instant, the person also finds many other shades of color difficult to distinguish.

How does one know if he is color deficient?
By recognizing some of the symptoms of color deficiency or taking a color-deficiency test. Color deficiency is not obvious. In fact, Dalton, an early scientist who first described color blindness, did not recognize his own color defect until age 26.

What are symptoms of color deficiency?
Color deficiency is suggested if other people often question a person’s choice of color in ordinary life. Another symptom is a person's preference for blues and yellows as against
reds or greens. Further suggestion of color deficiency is a person's difficulty in seeing veins or freckles. A color-deficient person is normally insensitive to fall foliage. Many color-deficient cannot distinguish black coffee from coffee with cream. Another symptom is the difficulty in recognizing the colored signals, which are used in marine navigation, in flight and on the highway. The color of painted surfaces is easier to see than that of colored fabrics.

Where can one be tested?
Eye practitioners are required in most states to test for color deficiency.

Are many people color deficient?
Yes. In the United States alone, there are approximately 8,000,000 males and 400,000 females* who are color deficient. Unless tested it might take years for them to recognize they are color deficient.

Why is a person color deficient?
The accepted theory is that there are faulty nerve fibers in the cones of the retina. Since color is interpreted in the brain the mechanism it is not completely understood.

Is color deficiency a disease?
Not necessarily. It is an inherited, sex-linked characteristic. Some retinal injuries or diseases can cause color deficiency. Testing for color deficiency should be done for each eye.

What is color laziness?
A condition, which some color-deficient people appear to have, namely, a lack of interest in color.

Does a color-deficient person have difficulty in seeing objects?
Yes, depending on the background. For example, strawberries in the field or apples on a tree. Generally, it happens when figure and background are of confusing colors.

What colors are confusing?
A color-deficient person may find it difficult to distinguish
between red and green; between red, brown, and gray; between green, brown, and gray; between green, gray, and certain blues; between red and black; and between light blue and purple. Also he is often unable to distinguish between shades of the same color. Thus, he may confuse a cool yellow with a warm yellow. To a color deficient person, pink can look insipid and even gray. Further, he might see a dull yellow as orange or light green. In many instances, the only colors that a color-deficient person commonly recognizes are blue and yellow. Pastel shades of all colors are difficult to distinguish.

Are any occupations closed to the color-deficient?
Yes. Many occupations require normal color vision for example in the electronics industry where color-coded components are assembled. Color sensitivity is necessary in cosmetics, printing, agriculture, chemical analysis, textiles, plastics, photography, and art. In fact, there is practically no profession or trade which does not inherently use some colors as a means of identification.

Should a colorblind person drive an automobile?
Most municipalities try to improve the location of colored signal to accommodate color deficiency. There are restrictions in some countries (Canada, Bulgaria, Columbia) and in the USA particularly for interstate truck drivers.

Is it dangerous to be color-deficient?
It can be in marine navigation, aviation, and railroads where color signals are a vital part of the traffic-control system and when conditions are poor such as rain and fog.

What about hunting?
Accidental shootings are reported each year. In the typical forest or underbrush, a color-deficient person can easily mistake a fellow hunter for the animal or bird being hunted.

Is there any way to help color-deficient persons?
Yes, the X-CHROM Lens can help many who are color-
deficient.

**What is the X-CHROM Lens?**
The X-CHROM Lens is a red contact lens that is worn on one eye, preferably the non-dominant eye. It is available in a hard or soft lens.

**Is the X-CHROM Lens a recent development?**
No. It has been prescribed for more than 40 years. Prior to the X-CHROM Lens, there was no practical method to help the color deficient.

**What does the X-CHROM Lens do?**
It increases the number of shades that a color deficient person can see. Once new shades have been properly identified, the color-deficient person can learn to recognize colors that he never knew existed. With greater use, his sensitivity to color increases.

**Can a senior citizen wear an X-CHROM Lens?**
Yes. Depending on motivation, health and dexterity there is no age limit.

**Where does one obtain an X-CHROM Lens?**
Most eye doctors that fit contact lenses can fit an X-CHROM Lens.

**What if one wears contact lenses now?**
The X-CHROM Lens will not interfere with the regular use of contact lenses.

**How does X-CHROM work?**
The dominant eye or the eye without the X-CHROM lens, correctly sees blue and yellow but not red and green. The X-CHROM Lens on the non-dominant eye turns red and green into light and dark values. It provides clues so the brain learns that green is darker than red.

**How will colored objects appear with the X-CHROM Lens?**
There is more definition to a rainbow, fall foliage, paintings, and television.

**What is the first impression with an X-CHROM Lens?**
The color-deficient person first fitted with an X-CHROM Lens sees color as more "vibrant". Many new colors stand out but in time become one-dimensional.

**Is an X-CHROM Lens difficult to fit?**
No. It’s not different than fitting any conventional contact lens.

**Will the X-CHROM Lens reduce vision?**
The lens transmits enough light so visual acuity is not less than 20/40.

**Does the X-CHROM Lens interfere with binocular vision?**
No. Many people perform their usual duties

**Must X-CHROM be a contact lens?**
Yes.

**When can an X-CHROM Lens be worn?**
An X-CHROM Lens can be worn during a person’s waking hours in daylight or in an illuminated room. In general, an X-CHROM Lens can be worn at work, play, or driving a motor vehicle.

**Is X-CHROM important for children?**
Yes, when a youngster can take care of possessions an X-CHROM lens helps see educational material that’s color coded.

**What if one wears spectacles?**
Spectacles can be worn with the X-CHROM lens

**What spectacles can be used with an X-CHROM lens?**
Reading glasses or glasses to correct residual astigmatism. Glasses may also be used to correct a refractive error in conjunction with an X-CHROM Lens.

**What if no eye correction is needed?**
An uncorrected or Plano X-CHROM Lens is prescribed.

**Under what conditions should an X-CHROM lens be prescribed?**
An X-CHROM lens is prescribed for a mild red green color deficiency if there is no binocular vision problem and the
eyes are healthy.

Is X-CHROM safe?

Yes. X-CHROM is as safe as any conventional contact lens if complying with doctors instructions.

Is there any contamination from wearing the X-CHROM lens?

Not if the patient is compliant with cleanliness.

How long does it take to fit the X-CHROM lens?

The average period is between one to two weeks.

Is any special instruction needed?

No. Handling and use is the same as with regular contact lenses.

Will the X-CHROM Lens wear out?

Not any more than a regular contact lens. It can break if handled improperly or it may need retinting depending on the care.

Is the X-CHROM Lens expensive?

After the initial professional service it may cost slightly more than regular contact lenses.

Is X-CHROM guaranteed to help?

No. If there is no improvement at first it’s best not to proceed.

What is the value of X-CHROM?

It allows people to get jobs that require a reasonable sense of color vision. It contributes to children’s learning skills and offers more pleasure where color exists.

*Forms: Patient History

NAME____________________ DATE________________
OCCUPATION______________ Age______________

Your doctor needs the following information to help him prescribe the best treatment for your color blindness:

1. At what age did you first learn that you were colorblind?
2. How did you learn that you were colorblind?
3. Please write in what the following colors look like to you:
   - Red looks like
   - Orange looks like
   - Yellow looks like
   - Blue looks like
   - Pink looks like
   - Brown looks like
   - Green looks like
   - Purple looks like
   - Gray looks like
4. Which colors do you see best: fabric colors or paint colors?
5. Which do you see best - color TV or black and white TV?
6. a. Name the colors you see correctly
       b. Name the colors you see incorrectly
7. What colors do you enjoy wearing?
8. a. Can you match colors of clothing?
       b. Can you identify colors of clothing?
       c. Do you miss seeing some designs in clothing?
9. Does your occupation require that you are able to:
   a. Match colors?
   b. Identify colors?
   c. Recognize color design detail?
10. Give some examples for the preceding question
11. Name any colored objects that you have difficulty recognizing
12. State any learning difficulties that you have had in
13. Have you ever had difficulty seeing stoplights on an automobile when visibility is poor?
14. Do you occasionally fail to see a traffic sign?
15. What do the following traffic signal lights look like:
   a. Red appears
   b. Green appears
   c. Yellow appears
16. Describe a few of the things that you do to help you distinguish colors
17. Have you ever avoided doing something in your job because it required color knowledge? What was the situation?
18. Have you ever been denied a job or work because you are colorblind? If so, give details
19. What special precautions do you make because of your color blindness?
20. Has color blindness ever caused you any concern or depression?
21. Please state any further information on your color blindness that you think might be of interest
22. What other family members are color blind?

X-CHROM Evaluation

Note: It is recommended that this evaluation be done one month after fitting an X-CHROM Lens and then again five months later.

NAME_______________________________DATE OF X-CHROM RX
COLOR VISION DEFECT_________________________TODAY’S DATE
OCCUPATION____________________________
NON DOMINANT EYE____________________________________

1. Present wearing schedule
2. Are you applying for new employment with X-CHROM? Type of Job
3. Has X-CHROM helped you in your present job? How?

__________________________________________________________________________
4. What color vision tests were used by your employer?
5. With X-CHROM how did new colors appear at first?
6. How long did 3-D effect last?
7. How long did fluorescence last?
8. Do colors appear more vivid?
9. What new colors did you learn?
10. At first, did one eye feel as if it was not working with the other?
11. If yes, how long did it last?
12. Do you have improved color sensation when X-CHROM is removed?
13. Do you wear X-Chrom at night?
14. Can you use your X-CHROM lens in dark areas?
15. Are you still learning new colors?
16. Can you wear sunglasses with X-CHROM? Comments
17. Has X-CHROM improved your ability to match and identify clothing or other objects?
18. Has X-CHROM improved your occupational or vocational color vision? In what way
19. Did you properly identify traffic signals before X-CHROM application?
20. Has X CHROM improved your judgment of colored signals? If yes, circle improvement. Green, red, yellow. blinking red versus blinking yellow.
21. Has X-CHROM improved your driving safety?
22. Has ask X-CHROM helped you view TV and the computer?
23. Name the colors you are positively sure of with X-CHROM.
24. Name any color you are not positively sure with X-CHROM.
25. Does X CHROM enhance your appreciation of nature? If yes, in what way?
26. Does X –CHROM allow you to see objects against backgrounds that were previously obscured. Does X –CHROM allow you to identify colors, which you previously could not? If yes circle the following colors which improved with X–CHROM Red, orange, yellow, Green, Blue, purple, pink, gray, brown pastels, fabrics, painted surfaces.
27. If a student is there an improvement of learning because of X –CHROM? If yes, How?
28. Is it dangerous?
29. Further comments?

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Special thanks to the New England College of Optometry that provided me with an education to serve patients in private practice and public health, while furthering boundaries in visual science and related disciplines. I encourage graduates to further the practice of optometry by recognizing territory yet to explore. ....... to specialize in subjects of interest that benefit mankind and publish discovery.