CONDITION

Color blindness

Learn how color vision deficiency affects color perception, what causes it, how eye doctors test for it, and which tools can make daily tasks easier.

WHAT IT IS
Reduced ability to tell colors apart

BODY SYSTEM
Eyes and vision

MAIN SYMPTOMS
Color confusion, faded colors, difficulty with color-coded information, colors differing between eyes

WHAT CAUSES IT
Inherited genes or acquired conditions

HOW IT IS DIAGNOSED
Color plate, arrangement, or anomaloscope tests

MAIN TREATMENT
Practical aids and treatment of underlying causes

CAN IT BE CURED?
Sometimes, acquired causes may improve

IS IT AN EMERGENCY?
Sometimes, with sudden new color vision change

LONG-TERM OUTLOOK
Inherited cases remain stable; acquired cases vary by cause

Overview

Color blindness is a reduced ability to tell certain colors apart. Eye care professionals often call it color vision deficiency because most affected people can still see colors. Complete inability to see color is much less common.

Color vision begins in the retina, the light-sensitive tissue at the back of the eye. The retina contains cells called cones . Different cones respond mainly to red, green, or blue wavelengths of light. The brain compares their signals to create color perception.

A person may be born with color vision deficiency, or it may develop later because of an eye condition, another health problem, an injury, or a medication. Inherited color vision differences are usually stable throughout life. An acquired change may become worse, improve, or vary

depending on its cause.

The main patterns are:

Color vision deficiency usually does not threaten eye health. However, it can affect schoolwork, driving-related tasks, work choices, food preparation, and the safe use of color-coded information. A new or sudden color vision change matters because it can be a sign of an eye, optic nerve, or neurological problem.

- Red-green deficiency: Difficulty separating some reds, greens, browns, and oranges. This is the most common inherited pattern.
- Blue-yellow deficiency: Difficulty separating some blues from greens or yellows from reds. This may be inherited or acquired.
- Complete color vision deficiency: Little or no color perception. Some inherited retinal conditions, including achromatopsia, can also cause strong light sensitivity and reduced visual sharpness.

Symptoms

Symptoms depend on the type and severity of the color vision difference. A person may have difficulty identifying colors that others see as clearly different. Colors may appear dull, washed out, or similar to one another.

Possible signs include:

Children may not realize they see colors differently. They may use an unexpected crayon, struggle with color-based classroom activities, or memorize color names without consistently recognizing the colors.

Severe inherited conditions can cause symptoms beyond color confusion. These may include reduced sharpness of vision, rapid involuntary eye movements called nystagmus , or discomfort in bright light.

A lifelong, stable color vision difference can usually be discussed during a routine eye appointment. Arrange a prompt assessment if color perception changes gradually, affects one eye more than the other, or appears with other changes in vision.

Seek urgent medical care for a sudden new color vision change, especially with vision loss, eye pain, flashing lights, a dark area in the visual field, severe headache, weakness, facial drooping, numbness, confusion, or difficulty speaking. Call emergency services for possible stroke symptoms or a sudden major loss of vision.

- Confusing red and green, blue and purple, or yellow and pale green
- Having trouble with color-coded charts, maps, wires, medication labels, or computer displays
- Choosing clothing colors that do not match as expected
- Needing help deciding whether food is ripe, browned, or fully cooked
- Relying on brightness, position, or labels rather than color
- Noticing that colors look different between the two eyes

Causes and risk factors

Most inherited red-green color vision deficiencies result from changes in genes carried on the X chromosome. Because many males have only one X chromosome, a single affected gene can alter their color vision. A female generally needs changes affecting both copies to have the same inherited pattern, although genetic inheritance can be more complex.

Inherited blue-yellow deficiencies and conditions with little or no color perception involve other genes and inheritance patterns. These differences are present from birth, even if they are not recognized until school, an eye examination, or workplace testing.

Color vision can also change after birth. Acquired deficiency may affect one or both eyes and may not be symmetrical. Possible causes include:

Medication-related color changes depend on the specific medicine and the person's health. Do not stop a prescribed medicine because of a suspected vision effect. Contact the prescriber or an eye care professional for advice.

The chance of an acquired color vision problem may rise with age because eye conditions become more likely. Diabetes and other illnesses that affect the retina, optic nerve, or blood supply to the eye may also increase risk. Having a family member with an inherited color vision difference raises the chance of carrying or inheriting a related gene.

- Diseases of the retina, including some inherited retinal disorders, diabetic eye disease, and age-related macular degeneration
- Optic nerve problems, such as optic neuritis or glaucoma
- Cataracts, which can make colors appear faded or yellowed
- Eye injury or exposure to certain toxic substances
- Disorders affecting areas of the brain that process vision

- Side effects from certain medicines

Diagnosis

An optometrist or ophthalmologist can test color vision. An optometrist provides eye examinations and manages many vision and eye health concerns. An ophthalmologist is a medical doctor who diagnoses and treats eye diseases and can perform eye surgery.

A common screening test uses plates made of colored dots. A number, line, or shape is hidden within the dot pattern. Ishihara plates mainly screen for red-green deficiency. Other plate tests can assess a wider range of color differences.

Additional tests may ask a person to arrange colored caps or tiles in order. These tests can help identify the pattern and degree of color confusion. An instrument called an anomaloscope may be used in specialist settings to measure certain red-green differences more precisely.

Each eye should be tested separately when an acquired problem is possible. The eye care professional may also check visual sharpness, pupils, eye pressure, side vision, the optic nerves, and the retina. Dilating drops may be used to widen the pupils so the inside of the eyes can be examined.

If the change appears to be acquired, the next steps depend on the examination and medical history. They may include retinal imaging, visual field testing, blood tests, neurological assessment, or a review of medicines and possible exposures. Genetic testing may help in selected inherited conditions, particularly when color deficiency occurs with light sensitivity, reduced vision, or other retinal findings.

Online color tests may suggest a difficulty, but screen settings, room lighting, and display quality affect the results. They cannot confirm a diagnosis or determine whether an eye disease is present.

Treatment and management

There is currently no standard treatment that restores typical color vision in most people with an inherited red-green deficiency. Management focuses on recognizing the specific color difference and using practical ways to reduce its effect.

Glasses or contact lenses with colored filters may increase contrast between some colors in certain situations. They do not create normal color vision, may alter other colors, and may not be acceptable for safety testing or occupations that require accurate color recognition. Discuss their limits with an eye care professional before buying them.

For acquired color vision deficiency, treatment is directed at the cause. Managing an eye disease, treating inflammation, removing a cataract, or safely changing a medicine may stabilize or sometimes improve color perception. The likely result depends on the condition and whether permanent damage has occurred. Medication changes should be made only with the prescribing clinician.

Helpful strategies include:

Children may benefit from seating with good lighting, clearly labeled art materials, and worksheets that use patterns or words as well as colors. Parents can tell teachers about confirmed color vision deficiency so mistakes are not treated as carelessness.

Some gene-based treatments for inherited retinal disorders are being studied. Experimental research should not be confused with an established cure for routine inherited color vision deficiency.

- Use phone apps that identify colors through the camera.
- Add text, shapes, patterns, or symbols to color-coded information.
- Label clothing, medicines, cables, craft materials, and household items.
- Adjust device accessibility settings, contrast, and color filters.
- Learn the fixed position of signals and indicators rather than depending only on color.
- Use a food thermometer and cooking time rather than color alone to judge whether food is safely cooked.
- Ask teachers or employers for charts and instructions that do not rely only on color.

Complications

Inherited color vision deficiency usually remains stable and does not cause blindness. Its main effects are practical rather than medical.

Color-based learning materials can create avoidable school difficulties. Adults may have trouble reading status lights, graphs, maps, laboratory results, electrical wiring, or safety labels. Some jobs in transportation, aviation, maritime work, electrical work, public safety, or the military have color vision standards. Requirements vary by employer and location.

People should not assume that a diagnosis automatically prevents a certain career. Occupational testing may evaluate the ability to complete specific tasks rather than rely on one screening plate. It is important to obtain accurate information before making education or employment decisions.

Color confusion may also affect medication safety, food selection, and recognition of skin changes. Labels, written instructions, and help from another person can reduce these risks.

The main medical concern with acquired color deficiency is the underlying cause. Delayed assessment could delay treatment of an eye, optic nerve, or neurological condition. This is why a new change should not be treated as simply a lifelong color difference.

Follow up

A stable, inherited color vision deficiency does not usually require frequent visits solely for color testing. Routine comprehensive eye examinations are still important because color vision does not indicate whether the rest of the eye is healthy.

Children with confirmed deficiency may need updated documentation when starting a new school or planning subjects that rely heavily on color. Older students can discuss career-related testing early enough to understand any formal standards.

People with an acquired deficiency should follow the schedule recommended for its cause. Follow-up may track color perception, visual sharpness, side vision, retinal appearance, or optic nerve function.

Contact an eye care professional sooner than planned if colors become more faded, the eyes begin to differ, or there is new blurred vision, pain, light sensitivity, flashing lights, or a missing area of vision. Sudden major changes or symptoms suggesting a stroke require emergency care.

Sources

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