

Information About “*Impaired Night Vision*” and “*Night Blindness*”

The National Institute for Rehabilitation Engineering (NIRE) is a non-profit organization which operated clinics for the development and dispensing of vision aids, with user training, from 1967 through 1987. These clinics assisted *hundreds* of people having permanent vision impairments ... and/or other disabilities. This paper discusses clinical methods and devices developed, tested and used during this 20-year period for assisting individuals having “*Impaired Night Vision*” or “*Night Blindness*.” Because the NIRE no longer operates these clinics, the information is being made available so that it can be used by others to help individuals having any of the covered disabilities.

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INTENDED READERSHIP: This paper was designed to be read and understood by people who have *impaired night vision* or *night blindness*. It is also intended for their families, employers, employment counselors, doctors, optical dispensers or therapists.

PURPOSE: The purpose of his paper is to assist interested people in better understanding the different types of impaired night vision, the various help options, and the inherent limitations of these modalities. *NIRE recommends that all vision patients be examined by their own eye doctors before seeking or buying any night vision aids.*

Background: The Cellular Dynamics of Night Vision

On the back inner surface of each eye is a unique tissue called the “retina.” All images entering the eye fall on the retina – just as images entering a camera fall on the film. The human retina contains two types of light-sensing cells:

- (1) The “**cones**” are specialized cells which fill the central part of the retina. The cones sense and discriminate colors. They also see most clearly, giving us our sharp, clear, fully colored, daytime vision. The cones, however, see only ahead but not to the sides (no peripheral vision), and they do not sense very dim light. The cones function with and complement the functions of other retinal cells called the “rods.”
- (2) The “**rods**” are specialized cells which fill the peripheral or the off-center portions of the retina. The rods see only in black, white and gray. They do not discriminate colors. The rods give us side or peripheral vision, in bright daylight, in very dim light, and in mixed lighting conditions such as being on a dark road at night with bright oncoming headlights shining into one’s eyes. In very dim light, with no bright lights visible, a person is probably seeing with his rods, only. *This is confirmed if everything appears in black, white and gray – without colors.* In a dim-light environment, with one or two bright pinpoint lights, the person sees with both the cones (for the bright light) and the rods (for the dim light). *Unfortunately, prolonged viewing of a bright light in a dim field causes the wide*

pupils to close to smaller sizes and may also desensitize the rods – temporarily reducing the person’s ability to see in dim light. Thus, nighttime drivers want oncoming cars to lower their headlight beams, to prevent their being blinded. Once the bright light is gone, the pupils open up again and the rod cells re-sensitize, thus restoring good night vision. Most aircraft and some autos use red lights to illuminate the panel instruments because this color does not contract the pupils or overload the rods.

People with normal vision have full complements of both cones and rods in their eyes. If a person has many missing or damaged cones, then he will likely have reduced visual acuity (day and night) that cannot be corrected with glasses. Also, reduced color perception and discrimination. People with many damaged or missing rods will usually have reduced peripheral vision and impaired night vision ... or even night blindness – also non-correctible with glasses. (*Other papers are available on request from The N.I.R.E. on such topics as “Impaired Color Vision”, “Impaired Visual Fields”, “Impaired Peripheral Vision”, plus more.*)

Types of NIGHT VISION IMPAIRMENT (and causes):

There are four main categories of “night vision impairment” or “night blindness.” These are listed and detailed in an order where the first category affects the greatest number of people ... and the last category affects the fewest number of people. The great majority of affected individuals are non-disabled people having only limited vision problems ... such as being unable to drive safely or comfortably at night. Fortunately, most of these people can be helped, simply and effectively. A significant minority, however, have more serious night vision problems, “night blindness” rather than “impaired night vision.” Most of these people can be helped although not all can be restored to “normal” night vision.

Category 1 – Blurred Vision in Dim Light ... with sharp vision in moderate to bright light. *These people see clearly in daylight but with blurred vision at night or in semi-darkness.* They usually do not complain of “too little” ambient light and they do not complain of glare. People with this problem are the most numerous of all the people with night vision impairments and are often in their 40’s or 50’s. **MOST CAN BE HELPED EFFECTIVELY** with a pair of prescription glasses prescribed especially for night driving or outdoors night vision at distance.

MOSTLY AFFECTED are people whose ages range from the mid-40’s to the mid-50’s who are starting to become presbyopic due to aging. Typically, the person has some slight refractive error that does not affect visual acuity in bright light ... but does reduce the person’s visual acuity in dim light. This results in the “blurred night vision” complaints. *In most cases, both eyes are affected equally. People whose two eyes react differently should refer to additional information below.*

THE CAUSE of “impaired night vision” in these cases is, most often, variation in the “depth-of-focus” of each eye with exposure to bright or dim light - and the resulting closing or opening of the eye’s iris. In bright light, with the iris closed and the pupil of the eye small or even “pinpoint,” there is great depth-of-focus so that objects near and far remain in sharp focus. This conceals minor refractive errors such as common myopia (nearsightedness) and/or astigmatism (non-uniform corneal curvature distortions). A person attempts to drive at night in an area that has little or no ambient artificial lighting. The pupils become large as the iris opens. More light comes into each eye so that there is no complaint of being “night blind.” However, with the large pupils, the depth-of-focus is reduced and the distant scene or road, sidewalk or other vehicles becomes slightly out-of-focus and blurred. This results in the complaint being: “impaired night vision.” *For some people, blurred night vision results from a problem with just one eye. For other people, both eyes must be similarly affected for the combined vision with both eyes to appear blurred. Therefore, both eyes must be examined and refracted using trial lenses.*

THE REMEDIES for this condition are usually simple and effective. One hundred percent correction is possible for most people who are affected. It is interesting that many with this condition do not wear any corrective lenses because, in bright light, they enjoy sharp vision. It is only with aging that the night vision started to become blurry. Some people do wear corrective lenses and still have this problem. Usually, the glasses were prescribed a long time earlier and slowly became outdated ... or else the person was refracted (and prescribed) in bright light rather than in dim light.

People with impaired night vision, as described in this section, should go to an ophthalmologist for complete examinations of both eyes. First, this will rule out various eye conditions or diseases. Then, it will give the eye doctor an opportunity to evaluate the patient’s visual acuity at distance, in very dim light, using trial lenses. It is recommended that dim-light testing be done using trial lenses two times. The first time, the eyes should NOT be dilated with eye drops. This will enable the doctor to ascertain that both pupils widen quickly and fully in the dim light, by themselves (without eye drops). Afterward, the pupils can be dilated with eye drops for “worst case” testing for reduced acuity or blurred night vision.

Once it is determined that this is the problem, namely that there is sharp vision with pinpoint pupils and blurred vision with open or enlarged pupils (due to reduction in depth-of-focus caused by the larger pupils), corrective lenses can be tried. So long as the trial lenses are used in dim light that emulates night driving conditions, with the pupils widened, lens prescriptions should be readily determined for effective “night driving glasses.” Happily, the lenses worn for the sharpest possible night vision will also work as well for day vision (when the pupils are pinpoint sizes). The reverse is not true. Lenses prescribed based on bright-light testing will work well for day vision – but not necessarily for night vision.

Category 2 - Blinding Glare and/or Halos Around Lights - disrupting useful night vision or blinding the driver... but with sharp vision in dim light when there are no lights to cause glare. *These conditions can cause deadly auto accidents.* People with this problem are very numerous and often are not otherwise handicapped. Typically, glare problems of this type are caused by lesions in one or both eyes.

In some cases, there may be a developing cataract in one or both eyes; in other cases, the cause can be the result of a scratch, lesion or other defect in the cornea of either or both eyes. Some people who undergo LASIK treatments develop these problems. Usually, these problems can be corrected, controlled or improved by appropriate medical or surgical treatments.

Note: People with normal fused, binocular vision may be unable to drive safely or comfortably at night when only one eye is damaged. This occurs because the brain fuses the images from the two eyes into a single composite image. Even if the excessive glare comes from just one eye, it can impair the composite image from both eyes, thereby resulting in accidents.

Most people with this type problem can be helped medically or surgically by a qualified ophthalmologist (medical eye physician). **Exceptions:** *Many patients with damaged corneas can be helped with corneal surgery or a corneal transplant. Some cannot, especially those having corneal scars from active, chronic viral infections that cannot be cured. The problem is that some of these patients would still have the viral infection after a corneal transplant so that the new cornea would quickly become damaged, just like the old cornea. For these “incurable” patients there still is hope because of special lenses or other devices that can provide functional help.*

In some cases that affect one untreatable eye (when there is a good second eye that does not have glare or halo problems), special glasses or other devices may be helpful. These are some possible methods for helping:

Remedy A - people with only a mild problem can sometimes wear special driving glasses while retaining the night driving use of both eyes. The lenses, clear or prescription (for giving sharpest night vision) can be “gradient tinted” so that glare can be immediately filtered out by merely moving the head and eyes slightly. **CAUTION: Never wear sunglasses while driving in dim light!** The gradient tint lets the driver selectively, and momentarily filter out the glare and does not compel him to lose night vision entirely as would uniform tint sunglasses. Either of two methods can be used for making these glasses: (1) gradient tint both lenses from top to bottom. Typical: 90% at top, graduating to 5% two thirds down. Or ... (2) gradient tint both lenses from left side toward right side. Typical: 90% at left side of each lens, graduating to 0% one third toward the right, from the left edge of each lens.

CAUTION: Be sure to GET DRIVER TRAINING On-The-Road, under night driving conditions, from a qualified driving instructor before driving alone at night.

Remedies For People with More Severe Glare or Halo Problem:

Remedy B – It is possible to wear a patch on the impaired eye when driving in lighting conditions where glare and/or halo problems occur. Advantages: the glare and/or halo problems are eliminated. Disadvantages: the driver has no peripheral or side vision on the side of the patched eye; he has monocular vision – not binocular stereoscopic vision – and may have difficulties judging distances and speeds (until after much practice). Or ...

Remedy C - Wear eyeglasses, Rx or clear, with a circle of black tape on the inside of the lens of the impaired eye. Advantages: the glare and/or halo problems are eliminated because there is no forward vision through the tape; peripheral vision to the side, has been preserved. Disadvantages: the driver has only monocular vision ahead – not binocular stereoscopic vision – and may have difficulties judging distances and speeds (until after lots of practice). Remedy C is preferred over Remedy B

Category 3 - Insufficient Perception of Dim-Light may lead to accidents.

There may be different causes for different people. Possible causes and possible solutions are discussed below. This condition, often referred to as: “**Night Blindness**” may be caused by something as simple as a vitamin deficiency, or by a controllable disease process such as glaucoma, or by a less controllable, progressive disease such as retinitis pigmentosa (which damages or kills the retina’s rod cells). Even when less correctible (as with retinitis pigmentosa), there are some special optical devices available that can be functionally helpful.

It is important for people with this problem to first have a thorough examination by an ophthalmologist. This should include visual acuity in both brightly lighted ... and dim-light conditions. It should include examinations of the eye’s cornea, lens, vitreous and retina. And it should include testing internal eye pressure and then plotting the patient’s visual fields. The pupillary responses to changing light levels should also be tested.

These exams will identify or rule out: (1) glaucoma (which is 100% treatable) and (2) retinitis pigmentosa (progression of which can be slowed but not stopped). If either of these diseases is diagnosed, then treatment must be started immediately to arrest or slow the disease. These two eye diseases typically result in BOTH night blindness AND reduced peripheral vision which worsens progressively over time unless treated.

NOTE: If both these diseases are ruled out, visual fields and pupillary responses are normal, and there is no apparent cause for the night blindness, then the patient may be lucky enough to have a correctible condition caused

by vitamin or nutritional deficiency. An ophthalmologist who is a retinal specialist should be consulted to determine if the night blindness can be overcome with vitamins, nutritional therapy, or medications.

Driving with either glaucoma or retinitis pigmentosa may or may not be feasible depending on the person's overall vision. If the daytime corrected visual acuity is less than minimum state requirements, the person cannot drive at all. If the daytime acuity is adequate, then the other two issues must be addressed: (a) visual field ... and (b) night vision (dim-light sensitivity).

VISUAL FIELD minimums are specified by some states but not by others. If your state has minimum specifications, then your eye doctor will know if you can or cannot be licensed to drive. If you meet the state requirements – or if there are none in your state – then driving is a matter of the driver's choice. Some hints:

Hint 1 - If overall horizontal visual field is less than 110 degrees, then do NOT drive.

Hint 2 – Assuming 20/30 or better corrected visual acuity and a horizontal visual field of 110 degrees or more: (a) have 180-degree wide angle inside rearview mirror installed in car; (b) be sure the car's outside mirrors are adjustable from inside the car; and (c) take a qualified driving instructor to train you, on the road, in constant head & eye movement scanning techniques ... and in defensive driving techniques ... appropriate for your unique situation. Daytime driving, only!

NOTE: Field-Expander WALKING GLASSES may be available for people with untreatable “Tunnel Vision” for functions other than driving. *Please see information below about “Field-Expander Eyeglasses for People with Tunnel Vision.”*

An uncorrectable NIGHT BLINDNESS problem mandates that the person NOT drive at night or at dusk. There is nothing that can be done about this, for night driving.

To facilitate safer walking in dim light for a Night Blind person, indoors or outdoors, either of these two assistive devices can be used: (A) an inexpensive fluorescent-tube floodlight that is battery operated and worn on a strap around the neck. Used, hands-free, this device enables a night blind person to more safely and easily walk around, indoors or outdoors, because it illuminates the way. A person might not be welcomed while using a visible light of this type, in a theater or restaurant because the light might disturb other people. Or ... (B) a hand-held night vision scope (somewhat costly) which is held to the eyes like a monocular or a binocular telescope. An electronic screen displays brightly enough to be seen with daytime vision, the dim nighttime scene it is viewing. These devices were designed for military use but are available commercially. They do not use visible light and so do not disturb others.

Visual Field Expander Glasses for People with “Tunnel Vision” can also be helpful to people with more severe peripheral vision losses. A normal field of vision is in the range from 130 to 150 degrees wide. Generally, a person with progressive peripheral vision loss begins to feel handicapped when his field decreases to 110 degrees or less. When walking, he has to keep turning his head and eyes back and forth to know who or what is on each side. By the time the field width has decreased to 70 degrees, the person is well aware of his handicap. Once it decreases below 50 degrees, it becomes increasingly difficult to walk safely. It is in this range, or slightly lower, that the person is apt to begin using a cane or walking stick for increased safety. The visual fields can continue decreasing until they are as narrow as 5 degrees. Again, effective treatment can completely stop the progressive field loss in people with glaucoma. Effective treatment may slow, but not stop, the progressive loss in patients with retinitis pigmentosa.

Some “Low-Vision” clinics can make “field-expanding” eyeglasses to help people with advanced tunnel vision, for functions other than driving. Examples: (A) for people with fields 75 degrees or wider, central vision remains essentially normal. What is lost is the side vision, to either side – and the ability to turn one’s head either way, to see to the rear. A vertical strip, base-out prism segment can be cemented to each eyeglass lens, toward the outside edge. This enables the person, with only a very small and quick movement of the eyes, to see to either side or around the side toward the rear. (B) for people with visual fields of 20 degrees or less, eyeglass lenses can be made in a special bifocal form. The top half of each lens is clear or the person’s distance Rx. In the lower half of each lens is a reverse telescope, or a door peephole viewer, which enables the person to see a large area view because it is reduced or minified to remain within the existing central visual field. The viewing angle and minification ratio can be varied to suit the visual field size, the visual acuity rating, and the functional needs of the patient.

Category 4 - Combinations of Two or More of the Above Conditions in the same person can result in the person becoming even more functionally handicapped. Sometimes, each problem can be separately helped ...after all have been identified. In other cases, some but not all of the problems can be helped, leading to functional improvements but not necessarily complete restoration to normal functioning.

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