RE:view

Rehabilitation and Education for Blindness and Visual Impairment

Volume 29 Number 3 Fall 1997

AER

Three Types of Glare: Low Vision O&M Assessment and Remediation

RICHARD LUDT

Glare is "the dazzling sensation of relatively bright light, which produces unpleasantness or discomfort, or which interferes with optimum vision" (Cline, Hofstetter, & Griffin, 1989, p. 292). Ophthalmologists have determined that if an individual is sensitive to glare, the problem exists in the corneal layers, lens capsule, lens cortex, lens nucleus, vitreous, or retina (Faye, 1986; Gawande, Roloff, & Marmor, 1992; Jose, 1983; Maino & McMahon, 1986).

A survey of O&M specialists and people with low vision has identified glare as the number one low vision O&M problem (Smith, De l'Aune, & Geruschat, 1992). Glare will continue to be a major problem for low vision clients unless they receive a comprehensive clinical and functional O&M glare sensitivity evaluation. Low vision optometrists Waiss and Cohen (1991) have highlighted the importance of an O&M glare assessment: "Quite often eye care professionals trivialize the problem [of glare sensitivity] and are cavalier in their replies to the patient, providing merely the stock answers of telling the patient to obtain either optical quality prescription sunwear or try over the counter sunwear in a more or less trial and error fashion" (pp. 345–346).

Finding a glare control remedy based solely on clinical glare sensitivity testing, such as the Brightness Acuity Tester (B. A. T.) or the Miller-Nadler glare tester, is difficult because those tests are not always reliable indicators of functional glare problems found in the environment (Gawande et al., 1992). The two goals of an O&M glare remediation program are to minimize eye discomfort and to maximize visual resolution.

Unless glare sensitivity is controlled, an effective low vision O&M training program cannot begin. In this article I provide information that can enable the O&M specialist to (a) plan an individually tailored functional glare assessment, based on the information in the client's low vision eye examination report; (b) objectively measure the client's sensitivity to three types of glare problems; (c) select the correct glare remedy, based on knowledge of glare control options and considerations (a visually impaired client who is sensitive to more than one type of glare may require a combination of glare control remedies); and (d) provide consumer education information to the client to ensure lasting glare control success. My recommendations can be incorporated into a functional low vision O&M evaluation without increasing the time needed to complete the evaluation.

In this article I discuss three types of glare—discomfort glare, veiling glare, and dazzling glare—and present them in a purposeful sequence that corresponds to the order in which glare assessment and subsequent remedies should progress. Dark-tint sunglasses, typically thought of as the simple and quick remedy for glare, is the remedy for only one of the glares discussed.

It is important to clarify a technical point about the brightness of color tint sunglasses: In this article I classify a color tint according to the percentage of total light that is transmitted through it, that is, "total light transmission"(TLT). A "light" tint is in the high range of 90–50% TLT. That is to say, half or more of the available light or brightness is transmitted through the lens of the sunglasses to the eye. A "medium" tint has a TLT in the 49–20% range (moderate range); a "dark" tint, a TLT in the 19–1% range (low range).

Discomfort Glare

Discomfort glare occurs when widely varied levels of brightness exist concurrently within the eye's visual field (Rosenberg, 1984). For example, a pedestrian, who is facing the sun (positioned just above a building roof line), is scanning for visual information about the path leading up to the building entrance. A conflict exists within the eye's visual field: The pupil dilates to allow in more light for examining the shaded area of the building entrance at the same time the pupil also needs to constrict to reduce the access of direct, overhead light from imaging on the retina. Rapid fluctuations in pupil size can occur as the eye scans varied levels of brightness within the field of view, possibly resulting in eye fatigue, tearing, headache, discomfort, and poor visual resolution (Rosenberg, 1984).

Although the human pupil can constrict or dilate in 1/5th of a second, the retinal cone and rod photoreceptor cells require more time to adapt (Miller, 1974). Clinical research has shown that the retina's cone cells need at least 7 minutes to reach a full photopic state (light adaptation), and the rod cells require nearly 1 hour to fully adapt to dark (Gregory, 1990; Wolf, 1960). The O&M specialist needs to understand that even if the rod and cone cells could adapt more quickly, the problem of discomfort glare would not be solved because the retina adjusts only to ambient light across the entire visual field (Miller, 1974).

Assessing Discomfort Glare

Before the functional assessment of discomfort glare begins, the O&M specialist should read and understand the report of the client's clinical eye examination. Diagnosis of the eye condition and the results of the visual field examination are important indicators of a client's potential sensitivity to discomfort glare. Clients with the following eye conditions generally have an intact peripheral field and are sensitive to discomfort glare: achromatopsia, albinism, aniridia, corneal dystrophy, detached retina, hypertensive retinopathy, age-related macular degeneration, cataracts, diabetic retinopathy, Stargardt's disease, cone dystrophy, toxic amblyopia, and histoplasmosis (Apple, Apple, & Blasch, 1980).

The O&M specialist should plan a discomfort glare assessment when the results of the visual field examination identify that the low vision client has an intact superior peripheral visual field with a radius extending 10° or more from the macula. The potential for lateral discomfort glare can be identified when the client's temporal visual field extends at a radius of 10° or more from the macula. In pedestrian situations, discomfort glare conditions are most prevalent during early morning or late afternoon when the sun is low on the horizon. The O&M specialist should document sensitivity to discomfort glare each time the client uses his or her hand as a visor to reduce the squint reflex and to increase visual resolution.

Remedying Discomfort Glare

The remedy is a visor with a proper size brim positioned on the brow to block the overhead light source from directly entering the pupil (Faye, 1986). The brim of the visor should extend forward from the client's forehead a minimum of 3 inches to achieve consistent control of discomfort glare. Bending the sides of the visor downward (to curve the brim) helps minimize lateral discomfort glare directed toward the eye from the temporal field of view. To block the maximum amount of discomfort glare, the client should position the brim of the visor as low on the brow as possible without interfering with functional vision (Rosenberg, 1984).

Although translucent side shields attached to the temple of spectacle glasses may also reduce lateral discomfort glare from the temporal side of the visual field, opaque side shields will reduce the transmission of necessary light as well as the visual field of view (Rosenberg, 1984). Tinted, yet translucent, side shields are recommended and are available through optical supply companies.

If discomfort glare is identified as the only problem, sunglasses are of doubtful value (Sliney, 1983). Tinted glasses will reduce the ambient brightness but make the dark areas darker and may render invisible details of shaded areas (Pitts, 1990).

Case Study of Discomfort Glare

Harold, a 69-year-old man with age-related maculopathy, complained of severe glare problems during his O&M intake interview. Clinical eye examination reports indicated that his best corrected visual acuity was OD: 20/200, and OS: 20/300. His bilateral central scotomas were both 4-5° in radius with intact peripheral visual fields. During the indoor and outdoor assessment, Harold experienced sensitivity to discomfort glare. When he wore his own 4% light transmission sunglasses over his spectacle prescription during the assessment, his ability to relate visually to the travel environment suffered. The examiner told him of the results of the glare assessment and the options recommended to control discomfort glare. He agreed to try a baseball hat with a 3-in. brim. The subjective response was positive indoors: The baseball hat effectively eliminated the bright overhead lighting. When Harold wore his hat, he did not need sunglasses indoors.

Outdoors, wearing his hat, Harold could tolerate more light and did not need sunglasses when the sun was low on the horizon. The objective evaluation of controlling discomfort glare demonstrated that Harold's visual resolution increased in situations of discomfort glare; he identified landmarks, drop-offs, obstacles, and overhangs at an increased distance. His stride and walking pace improved. Harold now felt confident about his ability to travel independently in unfamiliar environments.

Instructional Note

Low vision clients who are hesitant to wear any hat or visor may benefit from the following instructional strategy:

1. Begin the lesson by asking the client to experience a situation of discomfort glare without and then with a visor—any hat or visor of his choice with a 3-in. nontranslucent brim.
2. Select an environment causing discomfort glare with as many relevant pedestrian elements (e.g., a change in travel surface texture, the presence of a small obstacle in the client's line of travel, a curb or short flight of steps, a stair handrail, a contour change, a building entrance door, door hardware, planters hanging at head level, a bench, signs, landmarks, and address numbers) in the shade as possible.
3. Ask the client not to bring his hand up to his brow during this assessment. If the client experiences intolerable discomfort, then he should turn away from the light source. Having given all the instructions, ask the client to face the situation of discomfort glare without wearing a visor.
4. Ask the client to subjectively note his visual comfort, while observing and documenting the severity of the client's squint reflex.
5. Ask the client to visually identify the pedestrian elements while facing the discomfort glare situation and document his squint reflex, subjective visual comfort, and the visual distance at which he can identify the pedestrian elements. Document any unidentified elements.

6. Ask the client to repeat Steps 4 and 5 while wearing a visor.
7. Discus the results of the assessment with the client.

The O&M specialist should respect the client's objection to wearing a visor for cosmetic or comfort reasons. However, if properly presented, a strategy for remediating discomfort glare is a nonthreatening experience that allows the client to discover for himself if wearing a visor will improve his viewing comfort and visual efficiency.

Veiling Glare

Veiling glare (also called disability glare) is "stray light that interferes with visual resolution because it is random and thereby reduces the contrast of the figure/ground in the retinal image" (Rosenberg, 1984, p. 197). The scattering of light caused by ocular media opacities from such eye conditions as cataracts, corneal dystrophy, a translucent iris (iritis, albinism), vitreous opacities, and diffusion through the sclera produce this kind of glare (Beckman, Hard, Hard, & Sjostrand, 1992; O'Conner, 1988).

Assessing Veiling Glare

The O&M specialist should make certain that any sensitivity to discomfort glare has been resolved before beginning the assessment of veiling glare. Because veiling glare occurs within the ocular media, the client should first complete clinical diagnosis and medical treatment before an O&M assessment of functional veiling glare begins. The O&M specialist should read the report of the client's eye examination and then customize the O&M assessment, based on the severity, type, and location of the ocular media opacity. For example, the clinical report of "2+ posterior sub capsular cataracts, OU," characterizes the severity of the opacity with the use of a a numerical system, before mention is made that the cataract is one in which the opacities are concentrated beneath the capsule. The method that eye-care professionals use to rate the severity of an ocular media opacity is

1+ = immature (mildly advanced)
2+ to 3+ = mature (moderately advanced)
4+ = hypermature (far advanced)

Because veiling glare depends on short visible wavelength, the O&M assessment should be conducted between 10 a.m. and 3 p.m. when short wavelength light is most intense. After reading the eye report, the O&M specialist can confirm the client's degree of sensitivity to veiling glare by observing a squint reflex in the presence of short wavelength light. The O&M specialist's functional classification of the client's squint reflex as mild, moderate, or severe determines the proper veiling glare remedy. The assessment route should begin with the sun at the client's back. The O&M specialist must carefully observe and document the client's squint reflex on each leg of the route.

Surgical Remedy for Veiling Glare

When light waves and matter of the same size collide, the result is known as "Rayleigh scatter" (Rosenberg, 1984). The ocular veiling glare effect is similar to that which occurs when a person is driving an automobile on a foggy night. The light from the vehicle's headlights hits the fog's water droplets and scatters, reducing the driver's visibility of the road ahead. An environmental remedy for Rayleigh scatter takes place only when the fog clears.

In many cases, the ideal remedy for ocular Rayleigh scatter is to remove the cause of the eye's opacity. Pre- and postoperative tests of clients who have had cataract operations will provide direct proof of the success of this procedure. After the removal of the lens that has a cataract, the patient will immediately experience dramatic improvements in light tolerance, including improved thresholds for visual recognition of details (Beckman, Abrahamsson, & Sjostrand, 1991; Weiss, 1990).

Nonsurgical Remedies for Veiling Glare

After surgery, clients with remaining opacities in the ocular media continue to suffer the effects of veiling glare. If a client has a sensitivity to veiling glare, but surgery is not an option or not recommended, the doctor should suggest other veiling glare remedies.

By wearing a visor, the client can block the intense, short visible wavelength light entering the eye from overhead. Unfortunately, a visor alone does not eliminate all veiling glare. Short wavelength light can also reflect off environmental surfaces. All highly reflective surfaces, including snow, sand, and sidewalks, can reflect high amounts of short wavelength light; the resulting veiling glare causes squinting (Barker, 1990; Pitts, 1990; Wittenberg, 1986). Wearing a visor and selecting the proper chromatic (color) lens are the keys to remedying veiling glare.

When short visible wavelengths of light are absorbed, the remaining medium and long visible wavelengths that are transmitted to the retina tend to pass over any small opacities in the ocular media with minimal Rayleigh scatter (Rosenberg, 1984). That phenomenon explains the effectiveness of vehicular yellow foglights. The yellow tint lens of the foglight transmits only medium and long visible wavelengths of light into the environment (Miller, 1974). Medium and long visible wavelengths do not scatter off the water droplets of the fog as readily as short wavelengths of light. With less light scatter, visual comfort and resolution of the road increase for the driver of the vehicle. Likewise, when a client with sensitivity to veiling glare wears sunglasses with the correct color tint that absorbs the short to medium end of the visible spectrum, only the longer wavelengths, not scattered by the small opacities, reach the retina, thus minimizing Rayleigh scatter (Zigman, 1992).

The remedy for sensitivity to veiling glare is sunglasses with a light (90–50%, TLT) tint of yellow, orange, or red. Because the proper color tint is the remedy for veiling glare, people with low vision should choose a high TLT lens to enhance figure-ground contrast (see below, Light Transmission of Color Tint Sunglasses). For mild veiling glare, a light yellow tint that filters up to approximately 475 nm is recommended; for moderate veiling glare, a light orange tint that filters up to 525 nm; for severe glare, a light red tint that filters up to 575 nm.

Case Study of Veiling Glare

Manuel, a 28-year-old, has ocular trauma from a vehicular accident. His best corrected visual acuities are OD: 10/140 and OS: 4/700. The tangent screen examination indicated that Manuel has a central visual field of approximately 4° radius in each eye. Glass fragments are still imbedded in the stroma of his cornea, creating a 2+ opacity. During functional low vision assessments, Manuel showed no problems with discomfort glare, a result consistent with his reduced visual field. However, he consistently demonstrated a moderate squint reflex in the presence of short wavelength light conditions. It is significant also that when he wore his 10% TLT green-tint sunglasses, his visual comfort increased but his visual resolution decreased dramatically.

Once the glare problem was identified and Manuel learned about the available options to remediate moderate veiling glare, he selected 52% TLT orange-tint sunglasses. He participated in a visually oriented program in the presence of veiling glare conditions. While wearing the 52% orange sunglasses, Manuel maintained the same visual comfort as he had with the 10% green sunglasses. In addition, the increased light transmission of the light orange sunglasses enabled him to recognize visually relevant pedestrian information (his visual resolution) at a distance four times greater than he could have with the 10% green-tint glasses.

Dazzling Glare

Dazzling glare occurs when an individual has an abnormal visual sensitivity to the intensity of ambient light (photophobia). A photophobic person may have unusual difficulty adapting to dramatic changes in illumination and a slow recovery from glare (Jose, 1983). Two major causes of dazzling glare are dysfunction of the iris and retinal disease. Retinitis pigmentosa, Stargardt's disease, age-related maculopathy, retinal detachment, rubella, diabetic retinopathy, histoplasmosis, rod monochromastism, cone dystrophy, achromatopsia, and retinal laser photocoagulation all cause retinal damage and are examples of eye conditions where one would expect sensitivity to dazzling glare (Gawande et al., 1992).

The O&M specialist should be aware that some medictions can have side effects that cause abnormal sensitivity to light. For example, Rifabutin-related photophobia has been reported in AIDS patients (Arevalo, Russack, & Freeman, 1997). Suramin Sodium treatment for metastatic cancer of the prostate has also been associated with photophobia (Hermady, Sinibaldi, & Eisenberger, 1996). Ocular steroid treatment can result in eye pain, redness, and photophobia (Renfro & Snow, 1992). The client's eye care professional is the best person to determine if remediation of glare can be accomplished by a change in medication alone.

Light and Retinal Cross-Linking

The O&M specialist needs to understand how light is processed from the retina to the optic nerve and why individuals with retinal eye disorders are often sensitive to dazzling glare. When light stimulates the retina's rod and cone photoreceptors, a complex chain of photochemical reactions begins. Of the five classes of retinal neurons, only the rod and cone photoreceptors, the bipolar cells, and the ganglion cells form a direct pathway from the retina to the brain (Long, 1992). The remaining two classes of retinal neurons, the horizontal cells and the amacrine cells, form lateral pathways that modify and control retinal information (Masland, 1986).

Before any neural information is sent to the optic nerve, those cross-linking connections spread over the entire retina and are able to modify the neural transmission intensity of light to the brain. Any damage to these connections adversely affects the eye's ability to modify the light intensity, resulting in photophobia (Hecht, 1987).

Assessing Dazzling Glare

Before beginning an assessment of dazzling glare, the O&M specialist should make sure that any sensitivity the client may have to discomfort, veiling glare, or both has been resolved. Attempting to assess dazzling glare first often results in selecting the wrong glare control remedy and unnecessarily reducing the client's visual efficiency.

If the eye report indicates that the client has a retinal eye disorder, the O&M specialist can expect that the client will be sensitive to dazzling glare. The specialist should then plan assessment routes for both overcast and clear sunny days. Observing that the client squints after a sudden transition from a dim to a bright lighting environment should not be documented as sensitivity to dazzling glare. To achieve accurate results when assessing dazzling glare, make sure the client has approximately 7 minutes to adapt to the ambient lighting conditions (Gregory, 1990).

Having given the client time to adapt to the light, the specialist should document the three classifications of a client's sensitivy to dazzling glare as follows: (a) squint reflex only = mild; (b) squint reflex, complaint of eye discomfort, and a decrease in visual resolution = moderate; (c) eyes averted from the light source, a complaint of eye discomfort, and profound decrease in visual resolution = severe.

Remedies for Dazzling Glare

Eye care professionals who have a low vision client with photophobia caused by trauma or dysfunction of the iris may prescribe an opaque contact lens that has an artificial pupil (Nowakowski, 1992). Other remedies for dazzling glare exist for clients who decline an opaque contact lens or whose photophobia results from a retinal eye disease.

Only the three types of dazzling glare discussed in this article are resolved by lowering the entire visible light spectrum with chromatic tint sunglasses (CTS). A client with opacities in the ocular media, as well as a retinal disease, may already have the correct tint color remedy for veiling glare but continue to squint because of dazzling glare. The appropriate remedy for this dazzling glare is to lower the percentage of light transmitted through the tint color chosen to remedy veiling glare. People with low vision who are not sensitive to veiling glare may prefer a pair of gray tint spectacles. Gray is referred to as a neutral density color because it filters evenly all the visible wavelengths of light.

A low vision client who has mild sensitivity to dazzling glare should use a 90–50% range of TLT (high) to achieve the best comfort while maintaining the integrity of visual resolution (Goodlaw, 1991). Sunglasses with high light transmission also help the eye maintain as even an adaptation state as possible, and it is hoped the glasses also will minimize the difficulties clients experience when moving from one lighting condition to another. For moderate sensitivity to dazzling glare, 49–20% TLT (moderate) would be appropriate to evaluate. Severe sensitivity requires 19–1% TLT (low).

Once the proper ultraviolet protection of the lenses has been confirmed, no damage to the eye occurs if, during a pedestrian evaluation of color tint sunglass, the client uses a tint that transmits light so intense that it causes momentary discomfort (C. W. Keswick, O.D., personal communication, 1994). If the client complains that the tint is not dark enough, the O&M specialist should carefully review the results of the comprehensive glare assessment with the client before trying a darker tint. A trial period of several days is recommended to compare each individual pair of sunglasses (Morrissette, Mehr, Keswick, & Lee, 1984).

Light Transmission of Color Tint Sunglasses

Because excessive reduction of light to the eye decreases visual acuity, light transmission through the filter should be kept as high as the client can tolerate (Rosenberg, 1984). Phillips and Rutstein (1965) demonstrated that every percentage decrease in light transmission to the eye results in a corresponding percentage decrease in visual acuity. Therefore, the person with low vision benefits from the highest possible tint light transmission.

Once the specialist has determined the client's maximum tolerance for light transmission in bright conditions, a light-to-shade evaluation can begin. The objective of that evaluation is to determine what percentage of TLT allows the client to continue to maintain optimum visibility in varied illuminations.

An increase in TLT would be justified if the client continues visually to identify relevant pedestrian elements, at increasing distances, while maintaining viewing comfort in bright ambient illumination.

Final Evaluation of Color Tint Sunglasses

Because the goal in remedying dazzling glare is to find the maximum light transmission through the lens that the client can tolerate, the O&M specialist needs to consider the following when helping the client make the final selection of color tint sunglasses:

1. For viewing comfort, the lens should reduce squinting and tearing.
2. The lens that meets the assessment criteria for maximizing visual resolution should have adequate TLT to allow the client to travel through moderate changes in luminance without needing constantly to put on and take off the sunglasses.
3. The client should compare the differences between the suggested sunglasses and those currently in use and should check the results of the initial assessment against current distance thresholds.
4. The effect that the chromatic tint has on the client's color-brightness perception and his or her opinion of the cosmetic appearance, the ease of use, and the performance of the sunglasses are all crucial factors.

Case Study of Dazzling Glare

Ms. Smith, a 63-year-old woman with diabetic retinopathy, has received pan retinal photocoagulation treatments. Her visual acuity is OD NLP OS 10/40, and her visual field is OS 15°. Clinical and low vision O&M assessments determined that Ms. Smith had discomfort and sensitivity to dazzling glare. A proper visor quickly resolved the discomfort glare. The results of the dazzling glare assessment indicated that she had a severe photophobic sensitivity. After learning the results of the glare assessment, Ms. Smith compared 2% green- with 4% green-tint sunglasses. She discovered that she could easily tolerate the slight increase to 4% TLT and also realized that she could use her residual vision more efficiently. She then agreed to try 7% green sunglasses and continued to experience success. Finally, Ms. Smith worked her way up to 13% gray glasses. She found that she could tolerate a substantial increase in light transmission while visually maintaining her line of travel in conditions of dim luminance. The ability to see into the shade while wearing the sunglasses eliminated her tendency to veer. She also found that she could make a smoother and more rapid transition from dim to bright light than when she wore the 2% green sunglasses. In this case study, using the subjective and objective means of color tint sunglasses yielded a positive result.

Summary

Figure 1 contains a brief summary of the three types of glare and a rudimentary description of remediation strategies.

Final selection of sunglasses should be completed only after a comprehensive assessment of the following factors:

1. The client's eye history
2. Functional glare assessment in environments with varied illuminations
3. Consideration of all the client's desired travel environments and locales
4. The client's full understanding of the glare problem(s) and the advantages and disadvantages of glare control remedies

Figure 1. Summary of Remediating Low Vision Glare

Low Vision Key	Type of Glare Sensitivity	Remedy
The functional superior visual field extends at a radius of 10° or more from the macula	Discomfort glare	Wear a hat with a brim that extends at least 3 inches forward from the forehead. Use side shields for peripheral discomfort glare
Opasities are present in the ocular media	Veiling glare	Wear a hat plus: Light yellow or amber tint for mild veiling glare Light orange tint for moderate veiling glare Light red tint for severe veiling glare
Diagnosis of a retinal eye disorder	Dazzling glare	Wear a hat plus: 90–50% TLT tint for mild dazzling glare 49–20% TLT tint for moderate dazzling glare 19–1% TLT tint for severe dazzling glare

ACKNOWLEDGMENT

The author wishes to thank Gregory Goodrich and Jane Bennett for their helpful comments on an early draft of this article.

REFERENCES

Apple, M. M., Apple, L. E., & Blasch, D. (1980). Low vision. In R. L. Welsh & B. B. Blasch (Eds.), *Foundations of orientation and mobility* (pp. 187–223). New York: American Foundation for the Blind.

Arvelo, J. F., Russack, V., & Freeman W. R. (April 1997). New ophthalmic manifestation of presumed rifabutin-related aveitis. *Ophthalmic Surgery Lasers, 28* (4), 321–324.

Barker, F. (1990). Does the ANSI Z80.3 nonprescription sunglass and fashion eyewear standard go far enough? *Optometry and Vision Science, 67*(6), 431–434.

Beckman, C., Abrahamsson, M., & Sjostrand, J. (1991). Evaluation of a clinical glare test based on estimation of intraocular light scatter. *Optometry and Vision Science, 68*(11), 881–887.

Beckman, C., Hard, S., Hard, A., & Sjostrand, J. (1992). Comparison of two glare measurement methods through light scattering modeling. *Optometry and Vision Science, 69*(7), 532–537.

Cline, D., Hofstetter, H. W., & Griffin, J. R. (Eds.). (1989). *Dictionary of Visual Science* (4th ed.). Radnor, PA: Chilton Trade Book Publishing.

Faye, E. E. (1986). Visual function in the elderly. *Geriatric Ophthalmology, 2*(1), 25–29.

Gawande, A., Roloff, L. W., & Marmor, M. F. (1992). The specificity of colored lenses as visual aids in retinal disease. *Journal of Visual Impairment & Blindness, 86*, 255–257.

Goodlaw, E. (1991). Preventing cataracts and age related maculopathy. *Journal of Vision Rehabilitation, 5*(2), 1–8.

Gregory, R. (1990). *Eye and brain*. Princeton: Princeton University Press.

Hecht, J. (1987). *Optics*. New York: Charles Scribner's Sons.

Hemady, R. K., Sinibaldi, V. J., & Eisenberger, M. A. (March 1996). Ocular symptoms and signs associated with suramin sodium treatment for metastic cancer of the prostate. *American Journal of Ophthamology, 121* (3), 291–296.

Jose, R. T. (1983). Treatment options. In R. T. Jose (Ed.), *Understanding low vision* (pp. 211–248). New York: American Foundation for the Blind.

Long, M. E. (1992). The sense of sight. *National Geographic*, November, 3–41.

Maino, J., & McMahon, T. (1986). NoIR's and low vision. *Journal of the American Optometric Association, 57*(7), 532-535.

Masland, R. (1986). The functional architecture of the retina. *Scientific American, 255*(6), 102-111.

Miller, D. (1974). The effect of sunglasses on the visual mechanism. *Survey of Ophthalmology, 19*(1), 38-44.

Morrissette, D. L., Mehr, E. B., Keswick, C. W., & Lee, P. N. (1984). Users' and nonusers' evaluations of the CPF 550 lenses. *American Journal of Optometry and Physiological Optics, 61*(11), 704-710.

Nowakowski, R. W. (1992). *Primary low vision care.* Norwalk, CT: Appleton and Lange.

O'Conner, P. (1988). Effects of routine pupillary dilation on functional daylight vision. *Archives of Ophthalmology, 106*(11), 1567–1569.

Phillips, A. J., & Rutstein, A. (1965). Glare: A study into glare recovery time with night driving spectacles. *British Journal of Physiological Optics, 22*(3), 153–164.

Pitts, D. (1990). Sunlight as an ultraviolet source. *Optometry and Vision Science, 67*(6), 401–406.

Renfro, L., & Snow, J. S. (July 1992). Ocular effects of topical and systemic steroids. *Dermatologic Clinics, 10*(3), 505–512.

Rosenberg, R. (1984). Light, glare, and contrast in low vision care. In E. E. Faye (Ed.), *Clinical Low Vision* (2nd ed.) (pp. 197–212). Boston: Little, Brown.

Sliney, D. (1983). Eye protective techniques for bright light. *American Academy of Ophthalmology, 90(*8), 937–944.

Smith, A. J., De l'Aune, W., & Gersuschat, D. R. (1992). Low vision mobility problems: Perceptions of O&M specialists and persons with low vision. *Journal of Visual Impairment & Blindness, 86,* 58–62.

Waiss, B. & Cohen, J. (1991). Glare and contrast sensitivity for low vision practitioners. In B. P. Rosenthal & R. G. Cole (Eds.), *Problems in optometry: A structured approach to low vision care* (pp. 435–36). Philadelphia: J. B. Lippincott.

Weiss, J. F. (1990). Glare and mesopic vision before and after cataract surgery. *Journal of Cataract Refractive Surgery, 16(*1), 88–91.

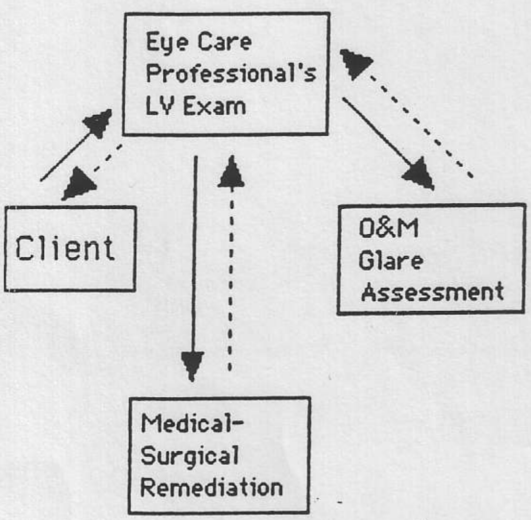
Wittenberg, S. (1986). Solar radiation and the eye: A review of knowledge relevant to eye care. *American Journal of Optometry and Physiological Optics, 63*(8), 676–689.

Wolf, E. (1960). Glare and age. *Archives of Ophthalmology, 64*, 502–514.

Zigman, S. (1992). Light filters to improve vision. *Optometry and Vision Science, 69*(4), 325–329.

Flow Chart for Low Vision
Glare Remediation

Rick Ludt
Western Blind Rehab Ctr



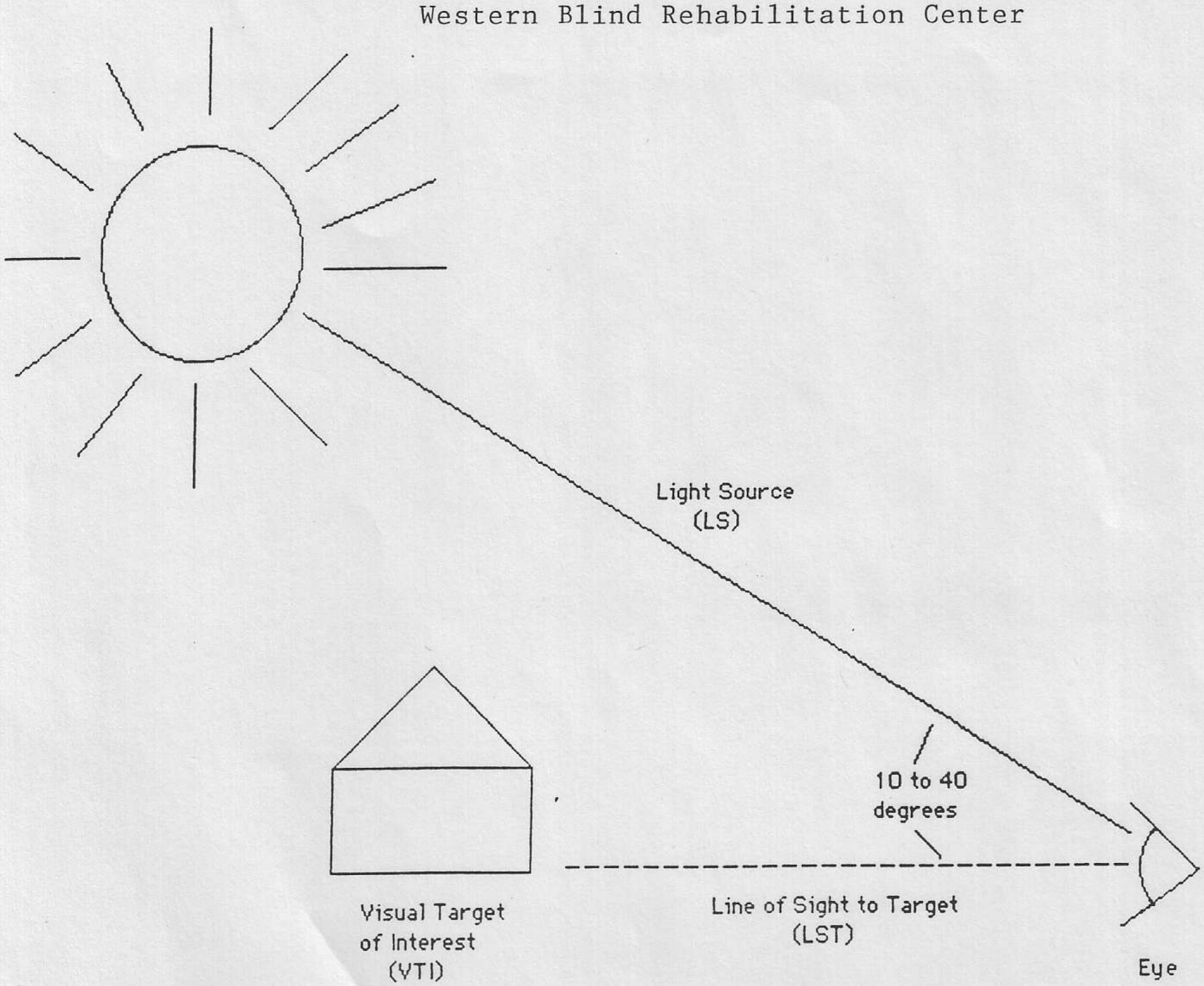
Low Vision Key	Type of Glare Sensitivity	Glare Remedy
The functional superior visual field (VF) extends at a radius of 10 degrees or more from the macula	Discomfort Glare (DisG)	Wear a hat with a brim that extends at least three inches forward from the forehead. Use side shields for peripheral DisG
Opasities are present in the ocular media	Veiling Glare (VG)	Wear a hat plus: Light yellow or amber tint for mild VG Light orange tint for moderate VG Light red tint for severe VG
Diagnosis of a retinal eye disorder	Dazzling Glare (DG)	Wear a hat plus: 90 - 50% TLT Tint for mild DG 49 - 20% TLT Tint for moderate DG 19 - 1% TLT Tint for severe DG
The functional inferior VF extends at a radius of 10 degrees or more from the macula	Spectral Glare (SpG)	Wear polarized lenses to filter SpG
A part or whole of the central visual field is functioning	Scotomatic Glare (ScG)	Wear a hat and tilt head downward just far enough to block ScG light source.

Discomfort Glare is quadrant of light dependant

by

Rick Ludt

Western Blind Rehabilitation Center



Discomfort Glare occurs when there are significantly varied levels of brightness that occur concurrently within the eye's visual field. The superior (upper) visual field can extend up to approximately 40 degrees from the fovea (central focal point of the visual field).

Practical Example of a Discomfort Glare Situation - Please refer to the illustration above. The person with low vision has a visual field that extends into the superior visual field greater than 10 degrees. The visual target of interest is the front entrance of a store. The sun is the light source and is facing the person with low vision at 10 to 40 degrees above the line of sight. As the person with low vision attempts to visually scan the front entrance for relevant pedestrian information, a light adaptation conflict occurs between the superior and central (or paracentral) quadrants of the visual field.

The brain commands the pupil to constrict and the eye lids to squint in an effort to reduce the bright light source from entering the superior visual field. Simultaneously, the brain realizes that the target of interest has poor contrast and illumination due to the fact that the light source is behind the house. The brain commands the pupil to dilate and the eye lids to raise in an effort to increase contrast. This results in the pupil dilating and constricting every 1/5th of a second with discomfort and poor visual resolution as a result.

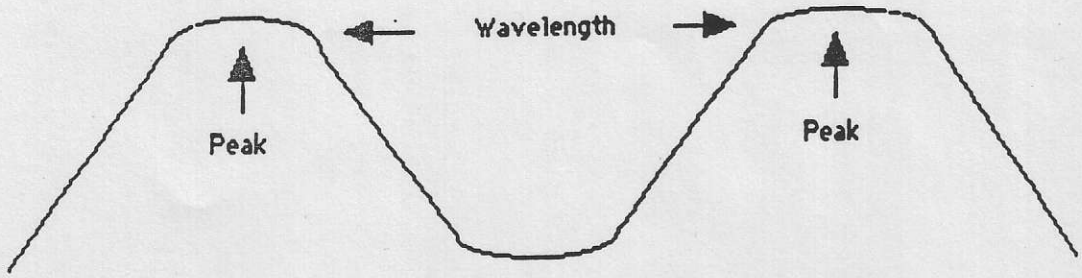
The remedy for Discomfort Glare is for all quadrants of the visual field to have equal levels of brightness.

Veiling Glare sensitivity is quality of light dependant

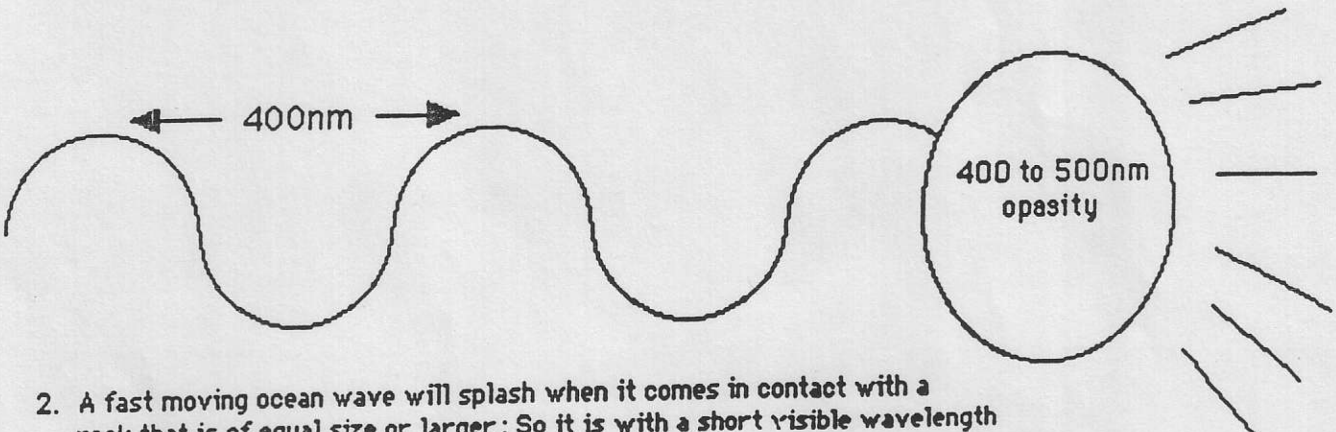
by

Rick Ludt

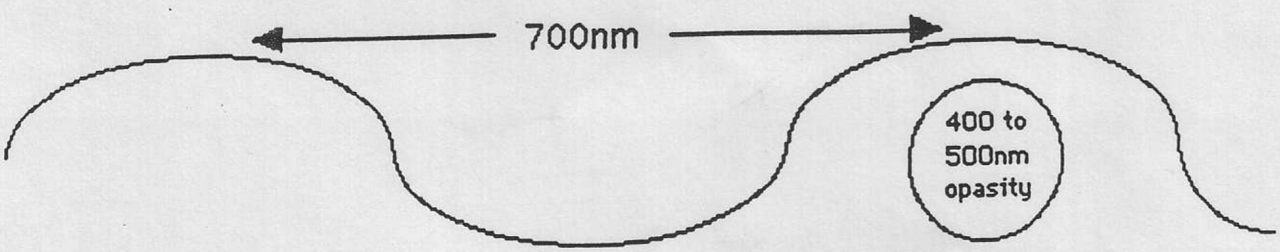
Western Blind Rehabilitation Center



1. The visible wavelength speotrum is 400 to 700 nanometers.
   Short Wavelengths are 400 to 500nm; Medium are 500 to 600nm; Long are 600 to 700nm.



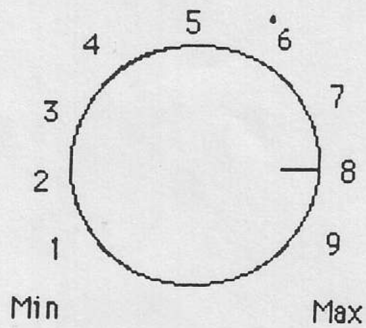
2. A fast moving ocean wave will splash when it comes in contact with a rock that is of equal size or larger; So it is with a short visible wavelength of light that comes in contact with an ocular opasity. The light is scattered by the opasity and can't be refocused on the retina. The brain may command the eye to squint in an effort to reduce the scatter effect. Loss of optimum visual resolution occurs for the person sensitive to Veiling Glare.



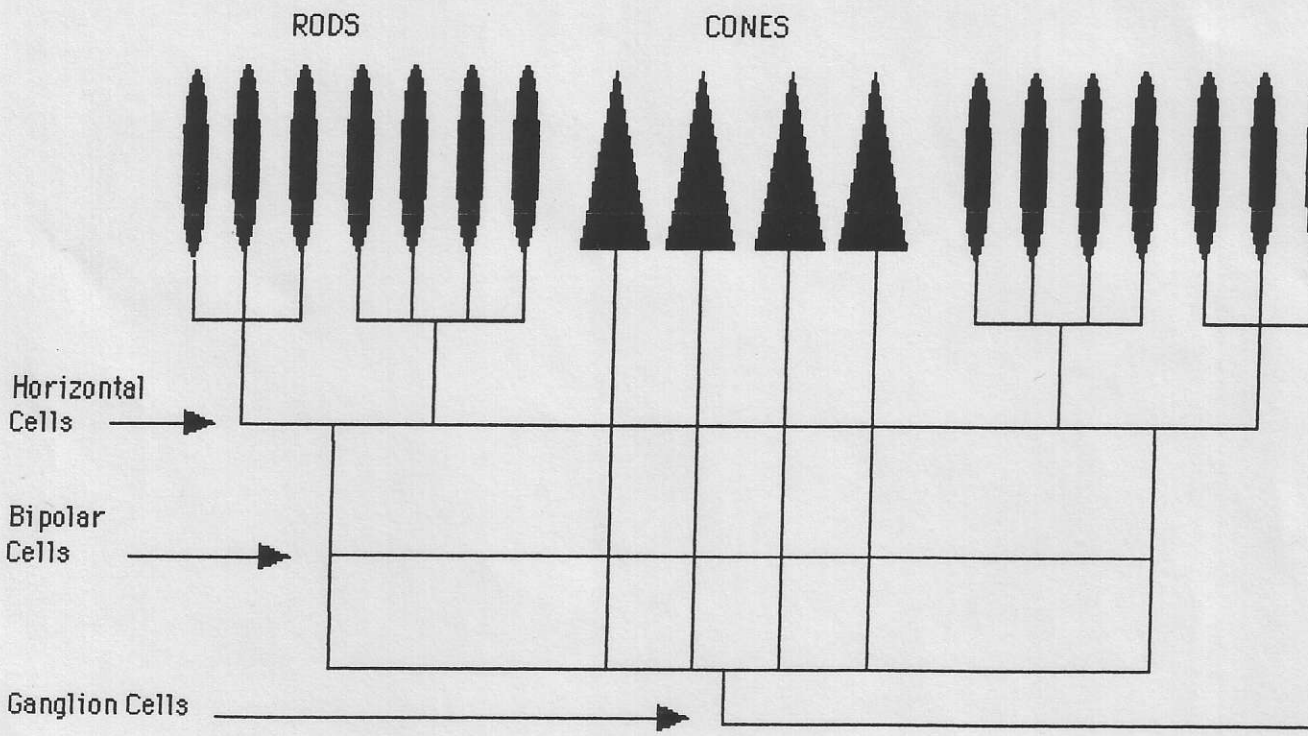
3. A fast moving ocean wave will not splash much when it comes in contact with a rock that is smaller in height; So it is with medium and long wavelengths of light that come in contact with ocular opasities. The medium and long wavelengths move over and around the opasity and are better focused on the retina. The remedy for Veiling Glare is to filter only the short wavelengths of light. Medium and long wavelengths of light can be focused on the retina for improved visual resolution.

Rick Ludt
Western Blind Rehab Ct

Dazzling Glare is quantity of light dependant



1. Before turning on my stereo, I always check the position of the volume knob. If the volume is set at 8, I know it will be too loud. I reset the volume to a more comfortable setting before turning on the stereo and listening to the sound. In a similar way, the retina cannot process light waves beyond a certain intensity level.



2. It is useful to remember that the retina is brain tissue. This means that the retina has the ability to process, categorize, and modify information before sending neural messages to the optic nerve and visual cortex. The eye's photoreceptors, rods and cones, receive the light source energy. One of the many categorizing jobs that the photoreceptors can do is to reduce the intensity of the neural signal before it is sent to the optic nerve, just like turning down the stereo volume knob before listening to music. Please look at the illustration above. The rod and cone photoreceptors are connected to the horizonal cells. These cells have cross linking connections across the geographic region of the retina. At the retinal level, if the horizontal cells determine that the overall intensity of the light energy is too strong for the visual cortex to interpret, then the signal will be modified before reaching the optic nerve.

A person with a retinal eye disorder will have severed lines of communication between horizontal cells. This means that the retina can't regulate the intensity of light. The person with a retinal eye disorder will be abnormally sensitive to light (Dazzling Glare). The remedy is sunglasses that absorb a percentage of light intensity before it reaches the retina.