Vision and the Musician

Michael F. Marmor, M.D.

For most musicians, vision is a vital part of the art. Performance may require physical dexterity, and ensemble a trained ear, but vision is the medium through which the wishes of the composer are transferred from page to performer. Even soloists who eschew music on the stage may be closet readers in the privacy of their own homes! This article discusses visual problems of particular relevance to the performing musician.

Optics of the Eye

The major visual problems of musicians relate to optics of the eye. As shown in Figure 1, the eye consists of a lens system (composed of cornea and lens) and a receptive layer for the image (the retina). Ideally, when the lens in an eye is fully relaxed the eye should be in perfect focus for far-away objects, a condition called *emmetropia* (Figure 2). However, many people have eyes that are too long or too short for their lens system. *Myopia*, or nearsightedness, results when the eye is too long, so that images of far-away objects come in focus in front of the retina even when the lens is maximally relaxed. Thus, distant objects appear fuzzy while close objects can be seen clearly because the diverging rays can be focused properly on the retina. *Hyperopia*, or farsightedness, results when the eye is too short, so that the images fall behind the retina when the lens is relaxed. This means that the hyperope must focus just to see things far away, and put more than normal energy into focusing to read or do other close work.

Reading requires that our eyes change focusing power in order to overcome the divergence of rays from letters that are relatively close to us (Figure 3). This is achieved by contracting the ciliary muscle which allows the lens in our eye to bulge into a more spherical shape (with higher refractive power). In youth, the lens is very elastic and becomes very powerful when the ciliary muscle contracts; thus, without changing glasses, an emmetropic child can see clearly far away and also inspect an insect 3 inches from the nose. However, as we age, the lens loses elasticity, becomes more yellow and increases in density, and is no longer able to gain much power when the ciliary muscle contracts. Thus, when a person over 50 (who sees clearly at distance) tries to read, the lens cannot change enough to compensate. This lack of focusing range is called *presbyopia*, and afflicts everyone by age 45 to 50 regardless of whether their basic eye shape is myopic, emmetropic or hyperopic.

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Presbyopia is corrected by wearing convex spectacle lenses that bend the rays diverging from a close object, and thereby compensate for the diminished focusing power of an aging human lens. Everyone over 50 who sees clearly at distance (naturally or with glasses) will need added lens power to read. Some myopes gain this power by simply removing their glasses, but most people must either carry a pair of reading glasses or wear bifocals. Reading glasses or bifocals are ordinarily designed for objects 14 inches away, which is the distance at which most people read.

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The impact of presbyopia on the musician is obvious: glasses that work for distance are no longer effective for reading music. However the routine solution, to wear reading glasses, may not work well because music on a stand is generally positioned farther away than a book in a lap. A musician may also need a wider field of view because of the head movement associated with playing. The best solution for the older musician is to have made a special pair of glasses that are set to the exact playing distance and that have a larger-than-normal bifocal segment (if bifocals are used at all). If the musician has no need to see clearly at distance or to walk around during the music, single vision glasses may be even better than bifocals.

It is important to realize that the near vision segments in a bifocal can be made to fit individual needs (Figure 4). A musician in an orchestra, who must periodically look up at the conductor, might have bifocals made with a very large bottom section for reading the music and only a small distance segment at the top of the lens. Players who do not wish to wear spectacles could have contact lenses made at the proper power for reading music, but these would not be bifocal and the performer would have to get on or off the stage in a blur. Bifocal contact lenses exist but do not seat themselves very reliably on most eyes and might be a hazard during a performance.

The key to success in finding the proper music reading correction is to personalize the glasses (or contact lenses) to each individual's style of play. A musician should carefully measure the distance from eye to music stand before consulting an eye doctor—or better yet, bring the stand right into the doctor's office.

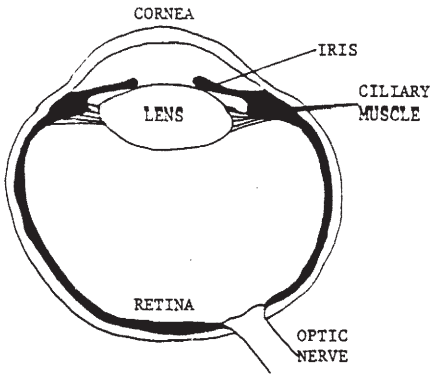

FIGURE 1. Diagram of the human eye.

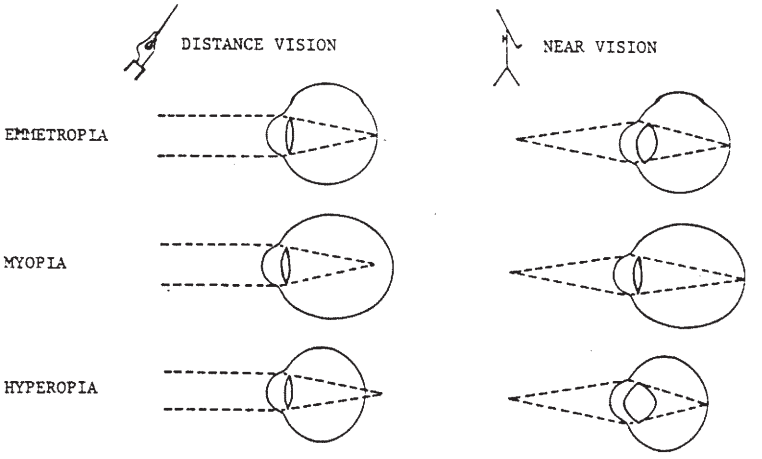

FIGURE 2. Optical states of the eye. Note the differences in eyeball size and shape. For distance vision, the focusing system is presumed to be fully relaxed; for near vision, the lens has changed shape to the degree necessary for each optical state.

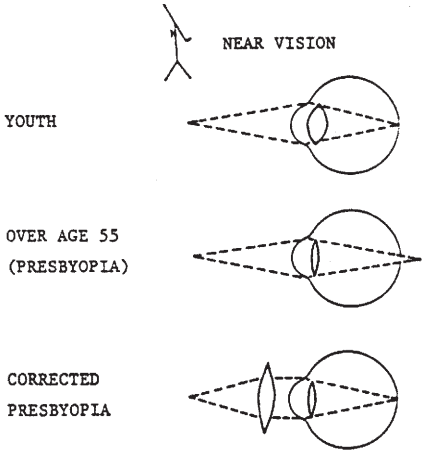

FIGURE 3. Near vision and presbyopia. The presbyopic lens can no longer adjust enough to focus on near objects unless a reading glass is used.

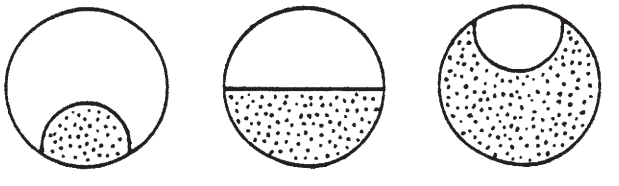

FIGURE 4. Bifocal lens types with the reading segments shaded. *Left*, conventional bottom segment. *Middle*, executive type bifocal. *Right*, specialized bifocal with a small distance segment on top.

Bifocal contact lenses exist but do not seat themselves very reliably on most eyes and might be a hazard during a performance.

Myopia and Radial Keratotomy

Myopia, or nearsightedness, is not a disease of great consequence since it is easily corrected with spectacles or contact lenses. There has been considerable recent publicity, however, about surgical correction of myopia with an operation called radial keratotomy. Since performing artists represent a group of individuals who may be particularly sensitive about wearing spectacles, it is important that they understand the pros and cons of radial keratotomy. It can certainly correct nearsightedness in many individuals, but it is not a panacea and there are definite risks to be recognized. Because radial keratotomy is easy and lucrative, some physicians have chosen to advertise its virtues in rather glowing terms. I would advise musicians, even those who do not feel comfortable with contact lenses, to do some careful research before they have a radial keratotomy.

The principle of radial keratotomy is simple. The surgeon makes a radiating set of deep cuts in the cornea, usually extending 90% or more through the wall of the eye. These cuts physically weaken the surface so that the normal fluid pressure inside the eye bulges the cornea slightly and changes its shape. People with moderate degrees of nearsightedness (2 to 5 diopters) stand roughly a 90% chance of achieving 20/40 or better vision without glasses, but very few people actually achieve 20/20 after radial keratotomy. The operation becomes less predictable with higher degrees of nearsightedness. Even if successful, the radial cuts leave the eye permanently weakened, and the fine scars in the cornea often cause glare, which could be particularly unfortunate

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for a performer working under stage lights. Because intraocular pressure fluctuates during the day, there is a tendency for vision to change slightly from morning to night, which might cause a musician to find music easier to read at one time of day than another. Finally, the operation corrects only the cornea and has no effect on the lens. Thus presbyopia will still supervene around age 45, and the person whose vision has been corrected by radial keratotomy to spectacle-free distance vision is still going to have to wear reading glasses or contact lenses to read music in his or her golden years.

Given these cautions, one can see that radial keratotomy may not be ideal for the musician. Furthermore, while a success rate of 90% may sound excellent, it means that 10% of individuals end up no better (and some of them end up considerably worse), which is a rather high penalty to pay when you start off with healthy 20/20 eyes. At the least, performers who wish to avoid spectacles should give contact lenses (especially soft lenses, which are relatively easy to tolerate) a serious trial before considering the irreversible and potentially problematic solution of radial keratotomy.

Glare

Glare from obtrusive lighting is a problem for all performers. It may be particularly bothersome to older musicians, because the ocular media (especially the lens) are slightly more cloudy than in the youthful eye, and tend to scatter more light. The most obvious solution to glare is to change the lighting, and hopefully many theater managers are sufficiently enlightened to listen to the plight of their charges. However, sometimes this cannot be done because the concert is outdoors (where the ultimate lighting director is often not responsive) or because constraints within the theater prevent further adjustment. One factor that is sometimes ignored is the color of lighting. In general, bluish or white light creates more glare than yellowish or warm light because blue wavelengths are scattered more effectively by the lens and ocular media. Thus, warm lighting will be more comfortable for most performers.

There are several ways to shield oneself from glare. The use of a cap or a visor is very effective when the lighting source is overhead, but may not be applicable to many performance situations. Less obtrusive but similar shielding may be obtained by having small shields attached along the top and sides of a spectacle frame. Another approach is the use of dark-tinted or colored spectacles (Figure 5). Most sunglasses are too dark for indoor use but glasses with a yellowish or brownish tint that filter the blue end of the spectrum can reduce greatly the subjective sensation of glare. A variety of ready-made yellowish "high contrast" glasses are available in ski or sports stores, and plastic prescription lenses can be tinted to order by most optical shops. Ultraviolet-absorbing plastics such as "UV-400" are only minimally yellow but may nevertheless reduce the sensation of glare considerably, especially in sunlight. Unfortunately, there is no "standard" or universally effective color that can be recommended; each performer must experiment to find the tint most suited to his or her working conditions. This experimentation might be done with the aid of a local optician willing to show you various colors by tinting lenses, bleaching them if necessary, and tinting them again. Hard contact lenses can also be tinted but soft lenses generally cannot.

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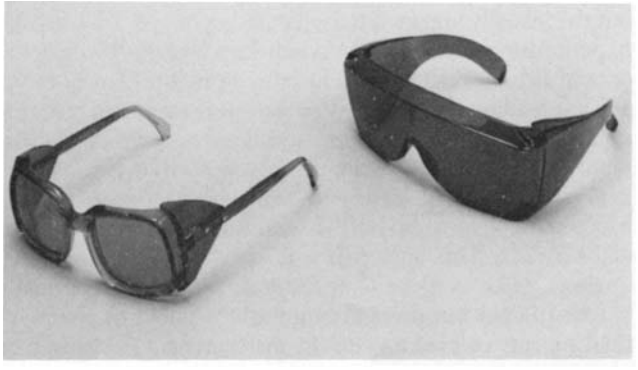

FIGURE 5. Two types of tinted spectacles with side shields. *Left*, Corning photosensitive lenses (yellowish to reddish). *Right*, Solarshields (amber). Other excellent brands are also available.

A final expedient that may have application in unusual situations is the use of colored paper for the music. Where the primary source of irritating glare is reflection off the music, yellowish or orange paper with a dull finish reduces the reflected blue light and lessens the discomfort. Whether orange music appeals to performers and whether it is worth the task of photocopying the parts, I will leave to trial and error experimentation.

Light Intensity and Adaptation

There are certain times, particularly in an orchestra pit, where the visual problem is simply inadequate lighting. Theater managers are torn between providing sufficient illumination for the musicians, and not bothering the audience or stage performers by light from the pit. I cannot resolve this fundamental conflict, since both players and audience are necessary to a successful performance. One notion occurs to me, however, that may have some application—although at present it is only a speculation. The retina contains two types of cells that primarily receive light, cones and rods. Cones operate only in moderately bright light to provide color discrimination and sharp reading vision; rods operate only in very dim light and are much less sensitive to red light than to other colors. Thus, reddish light is not only less likely than blue or white light to

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produce glare but levels of red light that appear dim to our daylight vision system also appear dim to our night vision system. The use of orange or even reddish lights on music stands might provide very satisfactory illumination for musicians (who must use their daylight vision system to read) but produce relatively little subjective sensation of brightness in the theater at large (where the audience is moderately dark adapted). Whether this works in practice, and whether red music is comfortable to read, will require field testing.

The Visually Impaired Musician

Visual impairment is obviously not unique to musicians, but the visually impaired musician faces the special difficulty of performing under adverse conditions where conventional optical aids may not work. The basic principle of most visual aids for reading is to magnify objects at the price of bringing them closer to the eyes. For mild degrees of visual impairment, for example, the simple prescription of extra strong reading glasses will suffice to make reading possible, but books may have to be held 7 inches from the face instead of 14 inches. This approach will work for music as well (if one sits twice as close to the stand, the print is optically twice as large) but there are limitations posed by the practical aspects of playing certain instruments. A string bass player may not be able to get within 6 inches of the stand without falling off the stool, a violinist playing too close would have an unreasonable risk of knocking over the music, and a brass player might find horn and music facing in different directions.

If circumstances allow it, the use of a strong reading correction and close placement of the music is the easiest and best solution to poor vision, but when that is not practical other options may be considered. For example, the music can be enlarged xerographically. However, there are limitations to this approach: nobody wants to play with a 4 × 6 foot page perched on an artist's easel, and if enlarged music is cut apart to the size of ordinary pages, the page turns become frequent and often unacceptable musically. Professor Leland C. Smith at Stanford University currently has a project under way to develop a computer program that will automatically print large-type music with reasonable page turns (Figure 6).

If one cannot get close to the music, why not use a telescope? This is theoretically feasible, but the high magnification produced by a telescope makes focusing very critical and any degree of head movement disruptive (think of the trouble it is to stabilize high power binoculars). It would be difficult for most musicians to use a telescopic aid, particularly one with a small field of view, and follow a line of music satisfactorily . . . let alone find the start of the next line. A telescope might be a useful adjunct, clipped to the upper portion of a pair of spectacles, for a visually impaired musician to peer up occasionally at the conductor.

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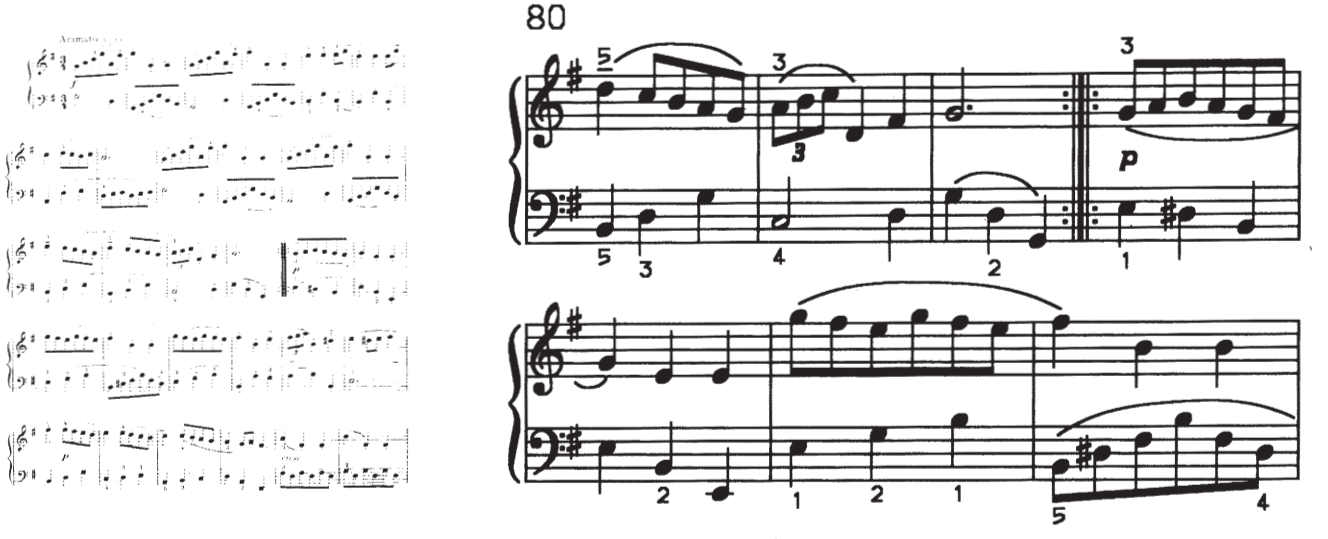

FIGURE 6. Two sheets of music, side-by-side for comparison. *Left*, conventional sheet music (minuet courtesy of J.S. Bach). *Right*, computer-enlarged music (courtesy of L.C. Smith).

I suspect, however, that the problems of motion will render this unsatisfactory. Furthermore, following the conductor is not nearly as difficult a task as reading music (speaking visually, not musically) since our eyes may recognize hand movement even when they cannot resolve the tip of a baton.

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Eye Disease

Neuromuscular disorders and stress-related psychologic disorders are common among musicians but there are relatively few risks of ophthalmologic injury or disease from playing music. One obvious concern, but fortunately rather rare in practice, is direct trauma from an errant violin bow, baton, or other sharp object. Most musicians have learned to seat themselves defensively so that this danger is minimal.

A less obvious problem, but one of which physicians who care for musicians should be aware, is the hazard to susceptible individuals from elevated ocular venous pressure while blowing hard on a wind instrument. For healthy people, blowing hard or straining causes no ill effects in the eye; however, if the intraocular blood vessels are unusually fragile, there is a theoretical risk of bleeding. This risk is present when abnormal and fragile new blood vessels ("neovascularization") grow under or into the retina. Neovascularization can occur in diabetic retinopathy (Figure 7), as a sequel to venous occlusive disease in the eye, and in some forms of age-related macular degeneration. In all of these disorders, the neovascularization has a high risk of bleeding on its own and, irrespective of wind playing, should be treated promptly with laser photocoagulation. After treatment, the chances of bleeding will be low in most cases, and wind playing should be proscribed only for those with active and persistent disease.

What is the risk for wind players with mild diabetes or early macular degeneration? It is low but finite, since neovascularization must start sometime, and the onset is often insidious and asymptomatic. These individuals should check their vision regularly and have periodic ophthalmologic examinations, so that any growth of new vessels will be recognized as soon as possible. I do not believe it justified to forbid wind playing, since the danger is neither predictable nor imminent.

Respiratory and venous back-pressure can stress the blood vessels but do not exert any force on the retina, independent of the eye wall. Thus, wind playing does not predispose to retinal detachment, even in individuals who are at unusual risk (such as high myopes or people who have had cataract surgery). Elevated pressure in or on the eye during intense blowing might be a hazard in the immediate postoperative period after cataract surgery until the surgical wound has fully healed (about 6 weeks).

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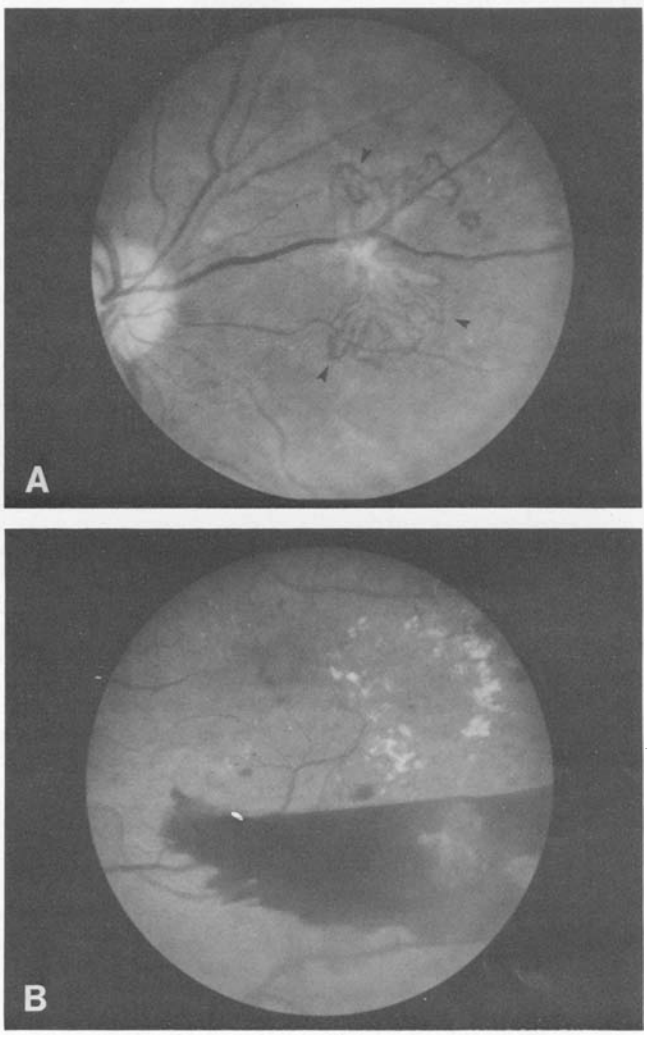

FIGURE 7. Proliferative diabetic retinopathy. *A*, arrows point to an area of abnormal new vessel growth (neovascularization). *B*, intraocular hemorrhage from diabetic neovascularization.

Summary

Although vision is critical for most musicians, the musical profession poses few risks to eyesight. The greatest problems for day-to-day performance relate to presybyopia in the older musician, and difficulties with glare and lighting for all players. Presbyopia is easily relieved with appropriate correction, but this may have to be tailored to the particular playing style and music stand distance of each performer. Glare and lighting are harder to control, but experimentation with colored lenses may be worthwhile. The visually impaired musician may have to sit close to the music or try some visual aids to see. There may be some risk of intraocular hemorrhage from straining on a wind instrument for individuals with active retinovascular disease such as proliferative diabetic retinopathy.