For many optometrists, an obstacle in providing a good outcome for a patient is “getting out of the office” and “getting into the patient’s world”. This obstacle is even greater when the patient is visually impaired.

**General Concepts:** It’s a good idea to explain the reason for the evaluation and what you will be doing. A surprising number of people who are referred for low vision rehabilitation don’t know why they were referred or what to expect. Also, include in the history family members who accompany the patient – but be sure to engage the patient and don’t allow a family member to take over the history process.

Whether your staff or you are asking the questions, obtaining a few more pieces of information may be critical to a successful outcome with your sight-impaired patient. Each patient will present opportunities for a careful history specific to their unique needs, but below are some examples to get you started.

**Essential Questions - consider including these questions in your standard low vision case history:**

- How would you describe your vision? How long have you had difficulty accomplishing daily tasks due to vision problems? Have you experienced changes in your vision in the past few months?
- What single visual task is most important to you?
- Are you living in your own home? Do you live by yourself, or who lives with you? Do you have a good support system?
- Are you having any problems reading your mail, the newspaper or magazines?
- Have you been an avid reader in the past? Do you still read a lot now?
- Are you able to see fine print on food and medicine labels?
- How do you manage a trip to the store? What do you do if you can’t read the price or label you’re interested in?
- Do you have difficulty with cooking or meal preparation? How often do you prepare meals? Do you use a microwave?
- How do you manage your medications? Can you describe this process? Have you ever made a mistake with your medications? Are you concerned you could make a mistake?
- Tell me about your television viewing habits. What do you like to watch? How far do you sit from your television? Do you watch television with other people?
- What kind of lighting do you use: task lamp, ceiling light, lamp with a shade?
- Do you use a computer? Is it a desktop, laptop or tablet? What distance do you sit from the screen? About how large is the screen? Do you use accessibility features?
Do you use a cell phone? Are you able to see it adequately? Do you use accessibility features?
Are you able to dial your phone? If not, how would you solicit help in an emergency?
Are you still driving? Have you restricted driving in any way, e.g. no night driving or no freeways? Have you had any close calls or accidents in the past year? Do you rely on others in the car to “co-pilot”?
Are you bothered by glare? Do you wear sunglasses?
What do you do (or what have you done) vocationally? If retired, how long? What are your hobbies?

**Discretionary Questions:**
- Are you diabetic? How do you check your blood sugar? How do you manage your insulin?
- How are you managing your finances, paperwork, bills, and/or checkbook?
- Where do you do your reading: Easy chair, couch, table, desk, bed?
- When was your last fall? What happened? Can you describe it to me? How many falls have you had in the past year? Do you ever use a gait aid or wheelchair?
- How do you manage reading menus in restaurants?

Questions like these allow you to provide better, more specific outcomes for your patients as well as letting them know that you are interested in their "functional world" and not just the world of your office. Your patients will appreciate this personalized care and you will appreciate the reduction in frustration and spectacle Rx remakes.

Additionally, a careful, thoughtful, and thorough functional history alerts you to those areas that may put patients at the greatest risk. Particularly for elderly patients, falls, driving, medication errors, and financial exploitation are of utmost concern when optimizing patient safety and independence.

Presented by the COA Low Vision Committee
March, 2017

**Accessing Visual Acuity in Patients**
**with Visual Impairment**

**CCVIP Provider Tip**

Visual acuity, the measure of the eye's ability to discern high contrast detail, is our most familiar, and arguably the most important, metric for visual function. It is the only test that is generally performed on every patient at every visit, and is often the most important piece of data in law suits that involve vision loss. Assessing visual acuity in patients with visual impairment requires different strategies and equipment than that used in primary care optometry.

**Distance Acuity Testing:**

The use of a moveable, high contrast chart with large optotypes is essential in determining the extent of visual acuity a visually impaired patient is capable of. The chart is "moveable" in that it can be presented at any distance. Any chart used for low vision must include optotypes between 20/400 and 20/200 as well as between 20/200 and 20/100.

There are two primary types of charts used in low vision: "Book" charts include the Feinbloom chart, which contains numbers as large as 700 feet (213M) and the LEA Number Book, with numbers up to 400 feet (120M) in size. These units of feet or meters tells the distance at which the optotypes subtend an angle of 5 minutes of arc. Visual acuity is recorded as the test distance over the optotype size. For example, if the smallest optotype correctly identified is 320 feet and was seen at 10 feet, you would record 10/320. If you prefer metric, you can record the test distance in meters and the optotype size in M, in which case 10/320 becomes 3/95M. Note that the decimal fraction (0.031) is the same. It all works as long as you don't mix units. For patients with very poor vision, begin with the largest optotype available at 10 feet (3 meters) and walk it closer to the patient until it is identified. With the Feinbloom chart you may get something like 4/700 if the 700 foot optotype is correctly identified at 4 feet. Advantages of the LEA Number Book over Feinbloom include optotypes that get smaller in consistent logMAR intervals, the optotypes are all equally legible, and a near chart is also included.

The most accurate visual acuity results from use of the ETDRS chart, named for the study it was designed for. It came about when the Bailey-Lovie chart was modified to include block Sloan optotypes. A new series of ETDRS charts was introduced in 2000 which features equal average legibility of optotypes on each row. Printed ETDRS charts are available in two optotype sizes, calibrated so the top row is 20/200 at 4 meters or at 3 meters. The charts can also be used by moving closer to the patient, but the math is much easier if the closer distances used are ½ or ¼ of the calibration distance. For example, if 4 meter charts are used, the top row is 20/200 at 4 meters, 20/400 at 2 meters and 20/800 at 1 meter. Not only does the ETDRS chart progress in regular logMAR intervals, but the level of crowding is equal in each row, because the spacing between optotypes is one optotype width. The charts may be used with a bright illumination source or backlit in a lightbox. An electronic ETDRS chart, displayed on a 40" television, is available from Acuity Pro and can be calibrated for any distance and the charts can be changed with a remote.
For patients with very poor visual acuity, the Berkeley Rudimentary Vision Test uses tumbling E and gratings to extend the range of visual acuity measurement to 20/16,000. If a patient is unable to discern any optotypes at any distance, then the practitioner should determine the following:

- **Form Perception:** "I can tell there is a figure there, but I can't tell you what it is."
- **Motion Perception:** "I can tell you are moving something in front of my right eye."
- **Light Perception with Projection (LPP):** "I can see some light and it is present on my right side."
- **Light Perception Only (LPO):** "I can tell the light is on, now it is off – but I am not sure where it is coming from."
- **No Light Perception (NLP):** "If you are turning on a light, doc, I can't tell."

In low vision rehabilitation we should never use "count fingers", which is a very gross test that is dependent on the size and contrast of the fingers against the background. If a patient can count fingers, he or she should be able to see a large optotype at a close distance. All of these findings are helpful in determining a patient's visual functioning and can be shared with vision rehabilitation teachers and orientation and mobility specialists for further vision rehabilitation care.

**Near Acuity Testing:**

There are many charts for near visual testing including tests with isolated letters, rows of letters, and continuous text. Keep in mind that each measures a different kind of visual acuity.

- **Near Snellen Notation:** If you decide to record near visual acuity in Snellen notation, you should state that the chart is calibrated for use at 40 cm (or other specified distance) but you tested the patient at a different distance. For example: On a near acuity chart calibrated for 40 cm, the patient was able to access 20/50 at 10 cm. This acuity would equate to 20/200 at 40 cm. It's almost impossible to convey these findings to another professional without causing confusion.

- **Metric, or "M" Notation:** Nearly all low vision providers prefer to use M notation. By definition, a 1M letter subtends an angle of 5 minutes of arc at 1 meter, a 4M letter subtends an angle of 5 minutes of arc at 4 meters, etc. The M system, like Snellen, is proportional, so a 2M letter is exactly twice the size of a 1M letter. Just like distance visual acuity, you should record the testing distance (in meters) over the optotype size (in M). For example, a patient who sees a 4M letter at 10 cm would be recorded as 0.10/4M. The beauty of this method is that you have the test distance, the absolute size of the optotype and the fraction, all in one expression.

- **Symbol charts** and HOTV may be used with young children, patients with intellectual disabilities or others who do not respond to traditional alphabetic visual acuity chart testing. LEA Symbols, Patti Pics and HOTV are well calibrated and tested and can be used with matching strategies with very young children. If presented as single optotypes, the use of crowding bars will improve the accuracy of the visual acuity testing.
Many times the low vision specialist has the privilege and responsibility of being a bridge between many services assisting in the patient’s vision rehabilitation process. The Metric (M) notation works best when expressing near visual acuity in the low vision rehabilitation field. However, if a report is written for the primary optometrist or ophthalmologist, vision rehabilitation professional (OT, CVRT, CLVT, COMS), vision teacher, rehabilitation counselor or the patient, the low vision specialist should be prepared to explain the near visual acuity findings in terms that can be understood by the recipient of the report.

For more information about testing visual acuities with visually impaired patients, contact the COA Low Vision Committee.

Presented by the COA Low Vision Committee
January, 2018

Refraction: Clarify before you Magnify!

A good refraction is the starting point for improving function in a visually impaired person. A 2010 study by Sunness and Annan found that of 739 new low vision patient evaluations that underwent retinoscopy and trial frame refraction, 11% improved 2 lines or more in the better eye on ETDRS chart (mean improvement 2.8 lines), and 3% in this group improved 4 lines or more. Meanwhile, in 15 subjects (2%) the worse eye on entrance VA was the better eye after refraction.¹ It’s important to clarify before you magnify.

**Trial frame refraction:** Using a trial-frame will allow the patient to move his/her head as needed and provides a larger field of view than a phoropter. The basic rules of refracting are the same. Start with an objective refraction or the patient’s current Rx. Pay attention to spherical equivalent when determining cylinder power and always recheck sphere after cylinder. (Depending on the situation, you may want to check sphere before and after cylinder determination.) Push the plus so that near vision will be less compromised by the distance Rx.

When refracting a low vision patient, consider the following tips:

- Make sure the optotypes used are above the patient’s threshold acuity and that the patient can keep the target(s) in view.
• Remind the patient to compare clarity, not whether “the lens makes the target appear or disappear”.
• It helps to hold each lens in place longer, especially if the patient has unsteady fixation. If the patient is having difficulty, ask them to tell you when to change lenses so they have ample time to take in each image presented.
• As you fine-tune the refraction, adjust JND based on the patient’s responses. What is JND??

**Just noticeable difference (JND):** JND is the amount of power change needed for a person to notice a difference in clarity. For example, a person with 20/50 acuity may need a 0.50D change in order to appreciate a difference. A person with 20/100 acuity may have a JND of 1.00D. JND is a good rule of thumb, but not everybody follows the rule. You will see people with a larger JND than VA would predict (a Fuch’s patient, for example) and those with a smaller JND than VA would predict.

**Finding sphere power:** You can either take the JND power and compare with vs without that lens, or you can bracket by sequentially presenting a plus and minus one half the JND. (If VA is 20/150, JND = 1.50D: Show +1.50 vs no lens; or show +/-0.75 one right after the other.) When a new power is preferred, replace the lens in the trial frame with the new combined power. It’s helpful to put the sphere power behind the cylinder lens so the cyl lens’ hash marks are easier to see. If your trial frame has a lens well on the same side as patient’s eye, powers greater than ~4.00DS should be placed there to minimize vertex distance.

**Finding cylinder power:** When determining cylinder power and axis, use a loose lens JCC that corresponds to one half the JND. For example, if the acuity is 20/100, the JND is 1.00D; therefore, use a +/-0.50D JCC. The procedure is the same as when using a phoropter: to fine tune axis, line up the dots on the JCC to the hash marks on the cyl lens. When fine tuning power, line up the colored hash marks on the JCC to the hash marks on the cyl lens. If the patient’s preference is when the red hash marks are overlapping the cyl hash marks, then more minus/less plus cylinder is needed. Change the cyl power by the same amount as the JCC being used. It’s important to keep the JCC stable when presenting each choice. Remember, it’s “a roll of the fingers” not “a twist of the wrist”! You will notice that when the handle of the JCC is aligned with the handle of the cylinder lens, the hash marks on each lens are aligned. Roll the JCC handle in your fingers while keeping your wrist stationary so the 2nd presentation is properly aligned.

Once finished, it is helpful to compare current glasses to the new refraction to give the patient an idea of how much of an improvement they can expect (or not) if they invest in new glasses. Have them look at the acuity chart, but also at “real world” objects, like faces or outside. Most trial frames have flex temples so that it’s easy to hold the trial frame in place by holding the temples without placing them on the ears. This for a faster transition from the trial frame to current glasses and back again, as needed. Make sure your arms aren’t in the way of what your patient is looking at.

Patients with central vision loss need to rely on paracentral vision to see detail better. Even if a person’s acuity is severely reduced, it can be beneficial to provide full correction instead of using a balance lens.
**Take-Home Message:** Optometrists are comfortable providing good refractions to our patients as we do this every day. Don't forget that the visually-impaired patient appreciates any improvement in acuity and will be grateful for this extra attention and testing.


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**The Brilliance of Illumination**

**CCVIP Provider Tip**

For many patients dealing with early vision loss due to macular degeneration, glaucoma, retinitis pigmentosa and some other conditions, adding additional task lighting is an important next step in helping them continue to read text and accomplish other tasks. It's difficult for a normally sighted person to understand just how important illumination can be. For some patients, illumination helps more than magnification!

To evaluate for the need for lighting, have the patient read a near continuous text card at the appropriate distance using standard, overhead lighting. Then, add additional light from your equipment stand's task lamp or another source. Evaluate what happens to your patient's reading fluency and their reported response to the illumination.

**What's In Your Lamp?**

There are three main types of light bulbs: Incandescent (including halogen), fluorescent (including compact fluorescent) and LED. Due to their heat production and poor energy efficiency, incandescent bulbs are on the way out. Compact fluorescents, which were the only other option for quite a few years, also have some disadvantages, such as a slow "warm up" time before they reach maximum brightness. LEDs have been improved significantly in recent years, and are by far the most energy efficient and cost effective, because of their energy efficiency and long life, which is roughly 20 times longer than an incandescent and 3 times longer than compact fluorescent.

Remember that the "wattage" rating of a light bulb is only a measure of the electricity it uses, not the amount of light (luminous flux) it puts out. The following chart provides a comparison of luminous flux (or brightness) and wattage (power consumption) of the three types of bulbs:

<table>
<thead>
<tr>
<th>Luminous Flux</th>
<th>Incandescent</th>
<th>Compact Fluorescent</th>
<th>LED</th>
</tr>
</thead>
<tbody>
<tr>
<td>400 to 500 lumens</td>
<td>40 watts</td>
<td>8 to 12 watts</td>
<td>6 to 7 watts</td>
</tr>
<tr>
<td>650 to 850 lumens</td>
<td>60 watts</td>
<td>13 to18 watts</td>
<td>7 to 10 watts</td>
</tr>
</tbody>
</table>
Color Temperature

The spectral qualities of light can also be important to patients, and it’s difficult to know which color temperature a patient might prefer. Many stores that sell bulbs have a demonstration area where you can try various color temperatures. In developing LED bulbs, the manufacturers have been good about listing the color temperature on the package. "Warm white" (about 2,000 to 3,000K) is most similar to incandescent, and includes more wavelengths from the red end of the spectrum. "Cool white" or "bright white" is more neutral at about 3,100 to 4,500K and "daylight" (4,600 to 6,500K) includes more wavelengths from the blue end of the spectrum. Some LED lamps have arrays of small LEDs with different color temperatures, which can be combined to provide a variety of color temperatures for the patient to choose from.

Fixture and Intensity

A bare bulb, or a bulb in a standard table lamp with a shade, emits light in all directions, and only a tiny fraction finds its way to the text your patient is trying to read. A fixture such as this is subject to the inverse square law, which states that as you get further from the light source, the amount of light received decreases by the square of the distance from it. A lamp with a reflector mitigates the inverse square law and concentrates the light enormously. A lamp with a shade and a task lamp with a parabolic reflector, both with a 1000 lumen bulb, have the same luminous flux, but the task lamp will have much greater intensity (flux per unit area). This can make a huge difference in the illuminance, or the amount of light delivered per unit area where you want it.

In the era of incandescent bulbs, we became accustomed to associating wattage with lumens. For that reason, an LED bulb may be advertised as "100 watt equivalent", meaning that they produce the same luminous flux as a typical 100 watt incandescent bulb. This sometimes causes confusion for the patient who wants a brighter bulb for their fixture that is rated for a "maximum of 60 watts". Explain to your patient that they could use a "150 watt equivalent" LED and it would still be safe, as it would use less than half the wattage of a 60 watt incandescent, for which the fixture was rated (see table above).

You Can Take It With You

Some patients have a need for a portable light source. Many patients with macular degeneration (especially those with foveal sparing or "ring scotoma") and also many with glaucoma, carry a small LED flashlight everywhere they go and use it to assist with short term reading. Battery-powered portable LED lamps are used by some people to see their food if they eat in a dark restaurant.

Patients with nyctalopia (such as Retinitis Pigmentosa) may require an extremely bright flashlight to assist with outdoor night time mobility, finding items in drawers and closets or fixing things around the house. These 1000 and 2000 lumen lights (usually with low, medium and high settings) come in hand-held and headmounted styles and may be battery operated or are rechargeable.
Take-Home Message
Adding task lighting for your patient may help as much, or more, than magnification, making it possible for your patient to read and accomplish other tasks much more efficiently and safely. Selecting the right fixture can be as important as choosing the right bulb. Portable options also abound. It's very frustrating when your patient does well in your exam room but not so well when they get home. This is often the result of having better lighting in your office than they have at home. Help them know what to shop for the next time they head to the lighting or local hardware store.

Presented by the COA Low Vision Committee
July, 2018

“Power On and Off the Nose”
CCVIP Provider Tip (LV 202)

Convex (Plus) Lenses, are typically available from +1.00D to +60.00D and are used in three forms: microscopes, hand-held magnifiers and stand magnifiers. Low vision providers use different forms of magnification to help visually impaired patients reach their visual goals and maximize their remaining vision. This article will focus on convex lenses and optical devices that provide hands-free magnification.

Microscopes
A high plus lens (or lens combination), that is mounted in a spectacle frame, is referred to as a microscope. These lenses may be full-diameter, lenticular, multi-focal or half-eye. The microscope is intended to be used with the reading material held at, or near, the focal point of the lens which creates a closer working distance and relative distance magnification. Regular, spherical lenses can be used up to about +10 D, and beyond that aspheric will provide better optics (reducing spherical aberrations). If a lens is used in a microscope over about +40 D an aplanatic (air spaced doublet) will provide the best edge-to-edge clarity.

Relative Distance Magnification (RDM)
If a letter on a page is moved closer to the eye, it is effectively enlarged. This can be expressed as:

\[ \text{RDM} = \frac{r}{d} \] where \( r \) is the reference (original) distance and \( d \) is the new distance.
So, if an emmetropic, visually impaired patient is needing a +10.00 lens to read small print, they would need to hold the print at the focal point of the lens (10 cm). If the patient is wearing a +2.50 D bifocal, then we can assume the reference point is 40 cm (standard reading distance):

$$RDM = \frac{40}{10} = 4X$$

The +10 D lens is providing clarity of the letter at 10 cm, but it is the change in proximity of the print to the eye (RDM) that provides the magnification and allows the visually impaired patient to access the smaller print.

Many patients initially reject microscopic glasses due to the closer reading distance, but once they understand that it is the “closer distance” that is allowing them to see the print, they may adapt more quickly. It should be pointed out to the patient that this option has two distinct advantages over using an optical hand-held or stand magnifier: Both hands are free and the field of view is significantly wider. Another tip to help with acceptance is, after you explain to the patient the need for the closer working distance, have them begin by holding the printed page at their nose, and then have them slowly move it out to the focal point of the lens. Many times, this strategy helps the patient be more accepting of the close distance as they feel they are moving it “farther away” instead of closer.

**Binocular or Monocular**

A patient's near-point of convergence (NPC) will vary, but many patients will have difficulty maintaining binocularity with lenses over +5.00 D. Many visually impaired patients are monocular, but others will benefit from having visual images from both eyes. An Amsler grid may be a good predictor of the need to maintain binocular vision. If areas of distortion or scotomas are significantly smaller using binocular vision vs. monocular vision, then binocular options should be explored more thoroughly. Even in a binocular patient, especially if the previously dominant eye is now the eye with worse vision, it is sometimes preferable to occlude the worse eye when designing strong reading glasses. This "worse eye" is not always the eye with worse visual acuity; sometimes it's the eye with worse contrast sensitivity or with many problematic central or paracentral scotomata.

**Base-in Prism and Convergence Demand**

Each patient is unique in how they adapt to a closer reading distance in their motivation as well as their focus and convergence demand. Using base-in prism can be very helpful in maintaining binocularity while using higher-plus reading glasses. But how much is enough?

Let's look at one more equation:

$$C = PD \ (distance) \times \frac{1}{(f + d)}$$

Where:

- **C** = Convergence Demand in Prism Diopters (\(^\Delta\))
- **PD** = Pupillary distance (@ distance) in centimeters
- **f** = focal length of the reading lens in meters
- **d** = distance from the “center of rotation of the eye” to the spectacle plane (0.027 m is assumed)
Example: If an emmetropic, orthophoric, visually impaired patient with a 62mm distance PD is needing a +6.00 reading Rx OU to access and read newsprint – what would be his convergence demand ignoring any induced base-out prism effect of a non-decentered lens)?

\[ C = 6.2 \times \frac{1}{(0.167m + .027m)} \]
\[ C = 6.2 \times \frac{1}{0.194} \]
\[ C = 6.2 \times 5.15 \]
\[ C = 32^\Delta \text{ (or } 16^\Delta \text{ per eye)} \]

Most low vision vendors who provide high-plus reading glasses will use base-in prism in lens powers from +4.00 to +12.00. The amount of base-in prism included is usually \(2^\Delta\) greater than the lens power per eye and the assumed PD is 64 mm. So, for a pair of +6.00 prismatic reading glasses, the glasses will contain \(8^\Delta\) per eye or \(16^\Delta\) total base-in prism. From the example above (\(C = 32^\Delta\)), you can see that this amount of base-in prism is not meeting the total amount of convergence demand a patient may need. The type and amount of phoria of the patient will also affect the patient’s final result, such that those with exophoria or poor convergence reserves may require more prism and those with esophoria or good convergence reserves may get by with less.

**Head-mounted Loupes and Clip-on Lenses**

Many companies offer head-mounted loupes as well as clip-on lenses in powers ranging from 2D – 28D. For example, Donegan Optivisors and Eschenbach clip-ons range in power from 2D – 10D for binocular viewing. Since the distance from the “center of rotation” of the eye to the reading lens plane is significantly increased, the convergence demand is less and some patients may tolerate these lenses even without base-in prism. Eschenbach also offers a +16 and a +28 monocular clip-on that some patients may find useful.

The head-mounted Optivisor may be used with or without a patient’s habitual bifocal Rx, so, they may choose to use the loupe in combination with their unaided vision, distance Rx or bifocal Rx, depending on the reading task. An LED “Quasar” light can be added to the Optivisor for added effectiveness.

**Telemicroscopes**

Telemicroscopes are telescopes that have been made to focus at a near point either by adding a “reading cap” or by having a focusing system that allows sufficient separation between the objective and ocular lens (near-focus telescope). These systems have the benefit of allowing the patient to view reading material in greater detail from and extended distance compared to a standard high-plus reading glass.

**Back to School:** A 2X Galilean telescope consists of a +10D objective lens and a -20D ocular lens. If this scope is used to view distant objects, parallel light enters and leaves the scope. However, for light that is coming from an object at 40 cm, the scope acts as a “vergence amplifier”.

**Example:** Light from an object at 40 cm will contact the +10D objective lens with -2.50D of vergence, and leave the objective with +7.50D of vergence. The light travels a further distance (we will avoid this equation) and contact the -20D ocular lens with +12D of convergence and leave the ocular lens with 8D of divergence. A patient will not be able to focus this light unless they are an uncorrected -8.00D myope or have a lot of amplitude of accommodation.
A +2.50D reading cap however, will allow parallel light to enter the objective lens and parallel light to leave the ocular lens and a patient is able to focus the image using their distance Rx. Lens manufacturers may also create a “near” telescope that increases the plus power of objective lens so it may only be used to view intermediate and near images but it may not be used for distance viewing.

The disadvantage of a telemicroscope is the decreased field of view, added weight, cost and the cosmetic appearance of the system.

Eschenbach’s 2.1X Max Detail is a unique telemicroscope in that it is light weight, has a larger field of view and is more affordable compared to other telemicroscopic systems. The system can be used for viewing computer screens, sheet music, playing cards and other intermediate and near tasks. For many patients, cosmetic appearance is still an issue however.

**Lighting**

Improving the task lighting, in conjunction with the above head-mounted devices, can be a critical factor in improving your patient’s reading ability with the above options.

**Magnifying Lamps**

Many patients, who are dealing with early vision loss, may benefit from magnifying lamps. The combination of the large field of view (from the typically used 3D lens) and the bright fluorescent or LED illumination, can be an excellent device for reading, writing, sewing and art/craft work.

Many patients enjoy the extended working distance compared to stronger reading glasses. To ensure clarity, have the patient focus larger print with their habitual bifocals or unaided myopia first, and then place the magnifying lens in front of the print at the appropriate focal distance. Some companies offer stronger lenses or lens combinations which may be helpful, but require closer working distances and a decreased field of view.

**Take Home Message**

Use “relative distance magnification” to your advantage and increase the plus power in the reading prescription of your low vision patients. Provide this option in conjunction with other magnifying options including magnifying lamps, telemicroscopes, hand-held & stand magnifiers, electronic magnifiers and digital devices. Determine the improvement in reading function by listening to a patient read a newspaper or magazine, and provide thorough explanations as to the proper use of the new device to avoid patient confusion once they leave your office.

**Please Note:** The following was used as a reference for this article:
Nowakowski, Rodney, W. **Primary Low Vision Care**. Appleton & Lange. 1994.

Presented by the COA Low Vision Committee
November, 2018
Nonorganic Vision Loss (NOVL) is encountered in clinical practice, particularly in the low vision optometry setting. It represents a condition whereby the extent of a patient’s symptoms do not correspond to examination findings. This article will review nonorganic vision loss and provide recommendations for additional reading for the eyecare provider.

Background and Historical Perspective
Nonorganic symptoms have been documented dating back to Homer’s Epics and the times of Hippocrates. Nonorganic vision loss spans a spectrum from the conscious “faking” of symptoms to the subconscious presentation of conversion disorder, whereby the patient experiences neurologic symptoms that are inconsistent with neurologic disease and cause distress or impairment. In conversion disorder, symptoms do not have a physiologic explanation but are not “faked” and do cause legitimate suffering. Conversion disorder is a DSM-5 diagnosis.

Conversion disorder is thought to effect 4-12 per 100,000 people in the general population and 5% of all patients presenting to neurology clinics. It is 2-3 times more common in females than in males and can occur at any age, but it is rare before age 10. The prognosis is considered poor with symptoms persisting or worsening in 40-66% of cases.

Functional Overlay is an additional diagnostic consideration whereby the patient has legitimate disease but presents with symptoms greater than what would be expected from the examination and known ocular history. In our experience, it is the most common manifestation of NOVL in routine practice.

Evaluation
It is not uncommon for patients to present with unexplained or exaggerated symptoms. It is controversial whether the conscious versus unconscious nature of a patient’s symptoms needs to be differentiated when presenting the diagnosis to the patient because it is impossible to know another person’s motives; however, it is incumbent upon the provider to rule out organic disease and to arrange for appropriate referrals when necessary. As eyecare providers, it is not within our scope to diagnose psychiatric disorders, but we should recognize when they may be present so as to facilitate appropriate consultation and care.
It is important to note that adults and children often present differently and may require more or less intensive evaluation, respectively. Malingering is more common in adults than in children. Additionally, when conversion type symptoms present in children, they tend to resolve quickly and spontaneously with a lower likelihood of recurrence.

A conservative strategy for evaluation is to first perform a complete and thorough examination of the eyes and visual system including visual field testing, imaging of the visual pathway, and electrodiagnostic testing. When addressing malingering, providers may also wish to employ tests of deception with the objective of demonstrating that a patient can indeed see, and moreover, that they can see in the exact way(s) they claim to have difficulty. The tests of deception include, but are not limited to, tangent screen at two distances, various dissociated acuity and reading tests, the testing of visual acuity at atypical distances or with non-standard tests, and the mirror test.

Chart Documentation
The modern approach to documentation is not to indicate whether NOVL is conscious or unconscious, but rather to use phrases such as, "Visual results are inconsistent with physical findings" or "Vision loss is disproportionate to physical findings" as in the case of Functional Overlay. Remember that a patient may someday have a copy of the medical record and the documentation should be clear, honest, and fair. A written diagnosis of malingering in the chart can limit a patient’s ability to access services and it may negatively impact the health care they receive in the future due to bias.

Presenting the Diagnosis
When presenting the diagnosis to patients and their families, it is important to be direct. In the case of suspected conversion disorder consider using the hardware/software explanation (the hardware is working and it seems there is a problem with the software) and acknowledge that the patient’s symptoms are real in the absence of organic disease. Consider drawing parallels between more familiar conditions and symptoms associated with stress, for example, hypertension, peptic ulcers, or the feeling of “butterflies” in your stomach. Establish the expectation that symptoms will improve without lasting impact. Strongly consider referral to a psychologist or psychiatrist, particularly in adults or in cases with longstanding symptoms.

In cases of malingering, explain that a thorough evaluation has been completed and that there is no evidence of disease; reiterate that it is not clear why the patient is having symptoms. Also, consider referral to neuro-ophthalmology and/or subspeciality retina to further confirm that there is no evidence of organic disease.

Treatment
When faced with patients diagnosed with conversion disorder, there are management considerations for the low vision optometrist. The treatment of conversion disorder beyond the mental health setting is controversial with options ranging from reassurance and an expectation of recovery to full scope inpatient rehabilitation. In the mental health literature, some authors advocate offering no more than reassurance and an expectation of recovery, while others recommend consultation for mental health services, particularly if the patient has or is suspected of having co-existing mental health diagnoses.
For patients with a more favorable prognosis for recovery (children, those with a shorter duration of symptoms, low suspicion of co-existing mental health diagnoses, and ophthalmic symptoms without other neurologic complaints), minimal intervention is often appropriate and sufficient; however, for patients with a poorer prognosis, additional rehabilitation may be an appropriate consideration. Rehabilitation strategies range from taking a therapeutic approach in cases with a better prognosis to providing compensatory strategies (for example, magnification, non-visual strategies, consultation for orientation and mobility) in recalcitrant cases. Therapeutic strategies in the vision rehabilitation setting are rarely mentioned in the literature; however, based on protocols used by physical therapy for other manifestations of conversion disorder, it seems reasonable that one could utilize basic visual skills training and blur interpretation techniques coupled with the expectation of recovery whereby positive responses to training are encouraged and negative responses are ignored.

<table>
<thead>
<tr>
<th>Prognostic Factors</th>
<th>Treatment Options</th>
</tr>
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<tbody>
<tr>
<td>Good</td>
<td>Reassurance Only</td>
</tr>
<tr>
<td></td>
<td>Therapeutic Activities</td>
</tr>
<tr>
<td>Poor</td>
<td>Compensatory Strategies</td>
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</tbody>
</table>

**Recommended Reading**

We recommend the following as additional reading on the subject of NOVL and neuro-ophthalmic disorders more broadly. *Functional Ophthalmic Disorders* provides an excellent historical perspective as well as a comprehensive overview of NOVL including the ophthalmic tests of deception.


**Take Home Message**

Non-organic vision loss is a vast and interesting topic. NOVL is not uncommon in clinical practice and providers should have a strategy for addressing these cases. It is also important to recognize that NOVL presents a myriad of ethical and potentially legal dilemmas.

Pane, Burton and Miller (2006) summed it up best: “True non-organic visual loss may be very difficult to diagnose and it is essential that patients with real but rare diseases are not falsely labeled as nonorganic. If there is any doubt, refer the patient to a neuro-ophthalmologist (urgently if vision loss is acute).”

**Please Note:** The content of this article is condensed from the American Academy of Optometry Low Vision Section Symposium: “Is this Real? A look at Nonorganic Vision Loss and Conversion Disorder” presented November 8, 2018 at the American Academy of Optometry annual meeting in San Antonio, Texas.

Presented by the COA Low Vision Committee
February, 2019

To access previous CCVIP Provider Articles (LV 202), go to www.colorado.aoa.org and click on “Programs” then “CCVIP” scroll down to the available links at the bottom of the page.
Power in a Hand-held (Angular and Relative Distance Magnification)

CCVIP Provider Tip Q2 2019 (LV 202)

High plus spectacles are a great, hands-free option if patients can adapt to the shorter working distance. There are some instances in which a shorter working distance is not plausible or cannot be accommodated. For example, it might be seen as socially inappropriate to have a can of beans or a new blouse 10 cm from one’s face. Hand held magnifiers are a great alternative in situations like this and can be used in occupational settings, checking the oven temperature or microwave buttons, reading price tags, checking the bus/train schedule or reading a map and many other day to day activities.

Relative Distance Magnification & Angular Magnification

Hand held magnifiers are an example of angular and relative distance magnification. When the hand held magnifier is held next to the eye, almost all the magnification is coming from relative distance magnification. As the magnifier is moved away from the eye, the relative distance magnification decreases and the angular magnification increases. To review, “angular magnification is the ratio of the angle subtended by the object and image. Subtended angles are related to the linear size by nonlinear trigonometric functions and depend on the distance from image to eye” (1). As the magnification increases in power, the field of view (in this case the lens diameter) will decrease in size. In addition, as the magnifier is moved away from the eye, the field of view will also decrease as is noted in the formula below:

\[ \frac{D \cdot f}{l} = FOV \]

Where \( D \) is equal to the diameter, \( f \) is the lens focal length, and \( l \) is the distance from the eye. All units are the same (e.g. cm).

When the magnifier is at its focal point, parallel light rays are exiting the magnifier eliminating the accommodative demand. This can be especially useful for students in reducing the accommodative fatigue they may be experiencing from a close working distance.

Patient Instruction – 2 mags in 1

Hand held magnifiers are not meant to be laid directly onto the reading material or object of interest. It may take a little practice for patients to find the “sweet spot.” One way to demonstrate this is to have patients start with the lens lying flat on the page and slowly pull it in towards their nose until the image is clear and at maximum magnification. The lens is meant to be held at its focal length away from the object if being used with the patient’s distance prescription. For example, a +10 D hand held magnifier is meant to be held 10 cm from the object. If the patient is using the magnifier with their bifocal, it must be held closer to the eye than the magnifier’s focal length to achieve maximum magnification. If held at the focal length or further, maximum magnification is achieved with the distance portion of the spectacle lens.
Another thought when demonstrating magnifiers to patients is that the hand held is two magnifiers in one. When field of view is not critical, like spot reading price tags and appliance buttons, patients can hold the magnifiers further from the eye than normal. When field of view is more important, like reading a restaurant menu, the magnifier can be held closer to the eye and be used more as a microscope, providing a much larger field of view.

**Importance of Lighting**
Hand held magnifiers often come equipped with lighting. This is a very useful feature, as many low vision patients have impaired contrast sensitivity and may struggle in poorly lit conditions (e.g. a restaurant). Some makes have different colored bulbs which can help enhance the contrast of different etiologies.

**Habitual Hand Held Mags**
Patients may bring in their own hand held magnifier that they got online or at a drug store. This is a positive sign, as these patients are trying to adapt and adjust to their vision loss; however, over-the-counter magnifiers are often not illuminated well (or at all), are not strong enough, and have poor optics. Most OTC magnifiers are +3-4 D in strength. The poor quality optics can be demonstrated with an Amsler grid. With the OTC magnifier, the grid will be distorted and blurry. A prescription quality magnifier should show considerably less distortion and sharper lines. If patients do come in with their own magnifier of unknown power, the dioptic power can easily be found in a lensometer.

**Challenges**
Hand held magnifiers are a good option for most patients with vision impairment, including those with a constricted field. However, they may not be the best option for patients with a hand tremor or dexterity issues. Patients may find increased distortion in the lens periphery as the working distance increases, which may cause some frustration with certain tasks. Additionally, if patients need stronger magnification, the lens diameter and field of view will decrease. This can be a huge turnoff for those patients who were attempting to use an OTC magnifier with a larger field of view or are expecting the hand held magnifier to be used for prolonged near tasks rather than spot reading. Most hand held magnifiers are battery operated with AA or AAA batteries. It is good practice to show patients or caretakers how to change the batteries. Rarely do patients get overly frustrated with this, but another thing to keep in mind if they have any dexterity or cognitive issues that would make it a barrier.

**Take Home Message**
To summarize, hand held magnifiers are a great, traditional optical low vision device that can benefit most patients with vision impairment. They allow for an extended working distance which may make certain daily tasks easier than with high plus reading glasses. They are lightweight and portable and most come with an illumination source to help aid contrast. The current low vision demographic is mostly familiar with these devices and they prove to be a user-friendly, low tech option. Hand held magnifiers should primarily be used for spot reading rather than extended near work. Hand held magnifiers are easy to store and have in clinic, no fabrication is needed prior to dispensing to the patient.

References
1. [https://mcanv.com/Answers/qa_aalm.html](https://mcanv.com/Answers/qa_aalm.html)

Special thanks to Dr. Tracy Matchinski for providing access to her laboratory and lecture handouts
Overview

Stand Magnifiers are convex lenses that are mounted at a fixed or adjustable distance from the reading material. The most common type of stand magnifier is fixed at a certain distance within the focal length of the lens. Thus, divergent light leaves the lens and the patient either needs to accommodate or use an add. Stand magnifiers are available up to +55D.

Stand magnifiers are useful for patients with hand tremors and those interested in prolonged reading tasks. Most stand magnifiers are illuminated to help enhance contrast. Many with visual field constriction find stand magnifiers helpful given their fixed working distance and illumination. Stand magnifiers are portable (though bulkier when compared to handheld magnifiers) and some are designed so that patients can write underneath. Stand magnifiers tend to be more popular amongst children and older adults.

Disadvantages to stand magnifiers include the need for accommodation, uncorrected myopia, or an add power for most magnifiers, decreased field of view when compared to microscopes, and they can be cumbersome. Stand magnifiers with illumination require batteries and patients will need to be shown how to change the batteries. In addition, the ergonomics of stand magnifiers may cause posture problems and may not be suitable for every patient.

Finding the Power Your Patient Needs

In order to find the power of stand magnifier the patient needs, you may use trial & error, or you may use the following equation:

\[ F_{eq} = ER \times F_2 \]

**Equivalent Power** \((F_{eq})\): The combined angular magnification from the stand magnifier and the relative distance magnification provided by the add, accommodation or uncorrected myopia. The answer provided is in diopters, and is equal in magnification to an add of that power. **For Example:** A stand magnifier with an ER of 3.0X used with a spectacle add of +2.50D provides the same magnification as a +7.50 (3 \times 2.50) spectacle add

**Enlargement Ratio** (ER): The true angular magnification of the stand magnifier (see below for more details).
\( F_2 \) is the power being used at the spectacle plane (add, accommodation or uncorrected myopia)

**Example:** A patient is reading 2M @ 40cm through a +2.50 add. During evaluation, you find that a +6.00D add allows him to read his goal of newsprint at 15cm. What is the needed Enlargement Ratio of a prescribed stand magnifier?

\[
ER = \frac{F_{eq}}{F_2} \\
ER = \frac{6.00D}{2.50D} \\
ER = 2.4X
\]

Tables are available that state the Enlargement Ratio for each of your stand magnifiers (see attached). You will want to select a magnifier that is equal to or exceeds the patient's goal magnification.

**Example:** The patient's goal is reading 0.8M print. The patient’s visual impairment is only allowing him to see 2M.

\[
\frac{2M}{0.8M} = 2.5X
\]

(assuming that the same add power is used for measuring the initial visual acuity is also used with the stand magnifier).

Using the Mattingly chart for enlargement ratio, their 4X (12D) has an ER of 2.9X which should provide enough magnification to achieve 0.8M print.

**Enlargement Ratio:**

As stated above, the enlargement ratio of an optical lens within a stand magnifier is the actual power (angular magnification) of the lens taking into account the distance from the lens in the stand to the object that is being magnified. Manufacturers place the lens inside of the focal point of the lens. Unfortunately, most “X” powers marked on stand magnifier labels don’t represent the true enlargement ratio of the lens. Two stand magnifiers with the same lens power, but different stand heights, have different ERs.

Following this article are lists of available illuminated stand magnifiers with their calculated ERs and image distances. Ian Bailey took these measurements for Mattingly Low Vision in 2008, and Optelec had David Simpson and Dave Lewerenz measure their product in 2014. Neither company publicize these findings as it may come off as embarrassing that, for example, your “8X” has a lower ER (magnifies LESS) than your “7X”. Eschenbach lists their ERs in the “Technical Specifications” pages at the back of their catalog.

**Image Distance:** Since manufacturers place the print inside the focal point of the lens, a stand magnifier (when held on the page) will create a virtual and erect image a finite distance behind the page. The patient, will need to focus this distance as well as the distance from their eye to the magnifier.
Although the stand magnifier will create enlargement, it also creates “relative distance MINIFICATION” since it focuses the object behind the page.

**Example:** If a patient is using a +3.00 add and holding a 5X stand magnifier with a stated image distance of 20cm, how far from her eye must she hold the magnifier to create proper focus?

The 5X magnifier will create a virtual image 20cm away from the magnifying lens. Her bifocal (+3.00) focuses at 33cm, therefore, she will need to hold the magnifier at 13 cm to achieve proper focus (13cm + 20cm = 33cm).

**Trial and Error with Understanding & Purpose**

**Example:** Your patient is able to read 3M print at 33cm using her +3.00 add. Her goal is to read magazine print (0.8M – 1M). What stand magnifier will allow her to reach her goal?

If your patient has never used a stand magnifier, present a 3X (ER=1.7X-2.2X depending on the manufacturer). Have the patient read larger print (below 3M) and listen to her reading pace and accuracy. Determine if the magnifier’s LED lighting is beneficial in her reading process (if this has not already been established during near acuity testing).

Once you establish the proper technique of using the stand magnifier with your patient, increase the power to 4X (ER=2.9-3.5X) or 5X (ER=3.0-3.6X). Have her decrease working distance to compensate the change in the “eye-to-lens” distance. Also, have her bring the magnifier and the print to her eye by “bending her elbows” and not “bending her back”.

Listen to her reading speed and accuracy when reading print at, and below, the 0.8M goal. If your patient is able to read (with good speed and accuracy) one or two lines below her threshold, she should be visually able to read her magazine print for an extended period of time. Finally, have her read a magazine with the magnifier to establish confidence.

**Dome Magnifier**

Dome magnifiers make a great first magnifying device for many pre-school and grade-school students. They fit well in a small hand, they rest directly on the page for easy use and the image is very bright without illumination.

As students get older, however, their vision may decrease and the print size they need to view will get more detailed. To compensate for these changes and to create more magnification, the student may need to decrease their working distance (using relative distance magnification) and they experience near point fatigue. This is largely due to the increase in accommodative demand at a closer working distance. Using a hand-held magnifier or electronic magnifier may be beneficial in decreasing accommodative fatigue.

It has been found that most dome magnifiers (with exception of some of the wedge-shaped magnifiers from Eschenbach) measure about 2X in ER, regardless of how the manufacturer labels the product.
Example: An emmetropic student that previously was able to view 18-point print in first grade with his dome magnifier at 15cm, needs to view fine print (4-8 point) on a map in 4th grade.

The student will be able to achieve 3x more magnification (using relative distance magnification), by moving the object from 15cm to 5cm, but he will also need to increase his amplitude of accommodation from 6.7D at 15cm to 20D at 5cm.

Prescribing Tips

Generally speaking, an add power of +2.50 to +3.50 D is prescribed for presbyopic patients using a stand magnifier as higher adds generally prove to be less functional. If a patient is holding a stand magnifier off the page, this is an indication that the patient may not be using their bifocal or, the distance from eye to magnifier is too long, or the patient is needing a stronger stand magnifier.

When using larger field, weaker stand magnifiers (ER=1.7-2.2X), patients may have more success using them on a hard surface such as a desk, table or lap desk. Using a slanted surface may make it easier to look through the magnifier perpendicularly and a large 3-ring notebook may be an effective and inexpensive option.

Take Home Message

To summarize, stand magnifiers are a great traditional low vision device that can benefit patients with vision impairment. They are a good “low tech” option for pediatrics and geriatrics or those with a hand tremor. Stand magnifiers are used in a system and accommodation, uncorrected refractive error, or an add will be needed to provide the patient with magnification and clarity. Training with stand magnifiers is generally simple, though ergonomics may be a challenge. Accessories like a lap desk may need to be considered to help with posture and fatigue. No fabrication is needed prior to dispensing stand magnifiers to patients and they are easy for low vision providers to store in their clinic.
“Honey, what’s the score?”
Magnification Strategies & Devices to View Distant Detail
CCVIP Provider Tip (LV 202)

Mr. Jones is an avid sports fan. He enjoys watching sporting events on his 32” television, he enjoys playing golf every Saturday morning and he loves to attend high school football games where his son is the head coach. The problem is, Mr. Jones has lost central vision from his long-standing macular degeneration. He is currently seeing 20/200 OD & OS with his best pair of eyeglasses. He is needing to improve his ability to enjoy his sporting activities and root on his teams.

Here are some options that may help Mr. Jones “stay in the game”:

**Target Acuity:** Knowing the target acuity for Mr. Jones is very helpful in determining proper magnification options. Determining the target acuity is not always straightforward. Seeing a golf ball on the tee will obviously be a less detailed task than viewing the golf ball on the green 150 yards away. Viewing the baseball player on the television screen requires less detail than following the ball off the bat or viewing the detailed graphics such as the score or the MPH of the pitch shone within the strike zone. Knowing the patient’s goals will help you determine the target acuity, usually from 20/20-20/50.

**The Television**

**Relative Size Magnification (RSM):** Increasing the size of Mr. Jones’s television set from 32” to 64” will provide 2X magnification which may be just enough to make the faces of the players more visible and the colors brighter, but it will not be enough magnification to see the scores and the detail printed on the screen. The 2X RSM will provide an acuity of approximately 20/100 (20/200 BVA / 2X = 20/100), not the 20/20-20/50 target acuity we are needing.

**Relative Distance Magnification (RDM):** Instructing Mr. Jones to decrease his viewing distance from his preferred 10 feet to 5 feet will also provide a 2X level of magnification as well, but moving him to 2.5 feet will provide a 4X level of magnification and some of the small print scores and other detail may start to become visible.

\[
RDM = \frac{r}{d}
\]

\[
R = \text{reference (original) distance}
\]

\[
d = \text{new distance}
\]

\[
RDM = \frac{10 \text{ ft}}{2.5 \text{ ft}} = 4X
\]

- **What is the Target Acuity?** Mr. Jones BVA of 20/200 / 4X (RDM) = 20/50 which is the top edge of our target goal of 20/20 – 20/50. We can reach the same 20/50 target if he purchases a 64” TV (2X RSM compared to his 32” TV) and move him to 5 feet (2X RDM).

- **Is “smaller” better?** A counter-intuitive approach would be to create more RDM by making the working distance MUCH closer and, at the same time, making the RSM less.

**Example:** If Mr. Jones happens to have a 12” tablet computer, he may be able to stream his baseball game on the tablet. If he has a +2.50 add, his working distance would be 16 inches (1.33 ft). Using our same RMD equation from above: 10 ft / 1.33 ft = 7.5X creating an acuity of
20/200 /7.5X = 20/27. However, we have also decreased the Relative Size Magnification from 32” to 12” creating a relative **minification** of 2.67X. So, the actual acuity would be 20/27 X 2.67 = 20/72.

If we fabricate a reading RX with an effective +5.00 add, his reading distance will move to 20 cm (8 Inches, 0.67 ft). 10 ft / 0.67 = 15X and 20/200 / 15X = 20/13. Factoring in the 2.7X minification of the smaller screen, this would give us: 20/13 X 2.67 = 20/35.

**Spectacle-mounted Angular Magnification for Continuous Viewing:** Most low vision equipment distributors carry “TV specs”. These 2.1X spectacle binoculars are lightweight, easy to use, provide a wide field of view, are cost effective ($100 - $200 retail) and may be worn for an entire movie or ballgame with good comfort. Stronger magnification may be evaluated using Beecher telescopes or telescopic systems may be fabricated by the optometrist using telescopic lenses from a host of manufacturers.

**The Decision:** Mr. Jones chose to move his chair to 5 feet from his new 64” TV. He purchased a 2.1X TV glasses to view movies from his couch (10 feet away), so he can sit next to Mrs. Jones. He also downloaded his cable company’s streaming app on his 12” tablet computer and ordered his new reading glasses (+5.00 add) to view his tablet clearly at 20 cm. With the tablet computer and new reading Rx, not only can Mr. Jones see much more detail on the screen, he is able to view the game in any room in his home.

**The Golf Course**

**Angular Magnification for hand-held “spotting”:** Prescribing a 4X-10X hand-held monocular will allow Mr. Jones to spot detail on the television screen, golf course and the football stadium, for short periods of time. Monoculars also have the added benefit to focus objects from optical infinity to 40 cm. The monoculars would create an acuity of 20/20 (10X) – 20/50 (4X). But which monocular should you choose, Galilean or Keplerian, and what are the plusses and minuses of each?

- **A Galilean telescope**, in its’ most simple form, consists of a plus objective lens located nearest to the object, and a minus ocular lens located closest to the eye. The lenses are separated by such that the posterior focal point of the plus objective lens coincides with the posterior focal point of the minus ocular lens forming an erect image.
- **A Keplerian telescope** consists of two plus lenses separated such that the posterior focal point of the objective lens coincides with the anterior focal point of the ocular lens creating an inverted image which needs to be corrected by prism or mirrors within the telescope.

More expensive telescopes have multiple lens systems designed to provide less aberrations and sharper images. A Keplarian telescope is typically longer than a Galilean telescope due to a longer path length of light.

For either type of telescope, the angular magnification (M) is the negative of the power of the ocular lens (F₁) divided by power of the objective lens (F₂). The final answer will state whether the image is erect (+) or inverted (-):

\[ M = -\frac{F_2}{F_1} \]
Most manufactures accurately calculate the magnification of the telescope and calculations are not needed.

**Which is Better, Galilean or Keplarian?**
- The Galilean telescope is shorter since it does not have to use an erecting prism
- Galilean telescopes max out at 3X - 4X
- The Galilean telescope is lighter weight and less expensive to manufacture
- The Keplarian telescope has a wider field of view due to the position of the “exit pupil”
  - The exit pupil is the image of the objective lens as formed by the ocular lens. The exit pupil of a Galilean telescope is formed inside the telescope, however, the exit pupil of the Keplarian telescope is formed outside the telescope and much closer to the entrance pupil of the eye, creating a wider field of view.

**The Decision:** Mr. Jones wanted to see pin placements on the green prior to hitting his golf shot. His playing partners were willing to spot his ball and let him know where his shot landed. The magnification of the proper telescope will vary depending on the distance he is from the green. The telescope will allow him to effectively bring the target 4X, 6X, 8X or 10X closer with the stronger power scopes creating less field of view. Mr. Jones preferred a 6X16 scope which brought his acuity down to 20/40 in the exam room. He was able to locate objects around the exam room effectively with the Keplarian 6X16 telescope.

**The Stadium**

**Hand-Held Binoculars:** Hand-held binoculars are basically two Keplarian telescopes, side by side, with prism systems to erect the images. Binoculars typically have a wider objective lens which provides a larger field of view, a brighter image and can provide a 3D view for those patients with binocularity. Most hand-held binoculars are not good for inside, TV viewing, since they are unable to focus the close viewing distances. However, hand-held binoculars can be a valuable asset for patients when viewing their bird feeder, site-seeing or going to a sporting event. They range in power from 4X – 30X (zoom binoculars) although high-powered binoculars are more sensitive to hand-movements and image instability. Eschenbach’s “Vision” 4X18 and 6X18 binoculars are a lightweight, mini-binocular that focuses at both optical infinity and up to 40 cm.

**Digital Magnification:** The use of smartphones and tablets are gaining acceptance in helping many patients view distant detail. Using the device’s camera and enlarging the images, provide a large range of magnification with good field of view, brightness and contrast. Optometrists need to ensure that proper reading prescriptions are in place to provide proper clarity of the digital screens that are being used.

**The Decision:** Mr. Jones wants to watch his son’s high school football team every Friday night during football season. He was presented with multiple options including relative distance magnification, hand-held binoculars, spectacle-mounted binoculars and using the camera on his tablet computer. He preferred using a 4X30 extra-wide fixed focus binocular when he was sitting closer to the action. He preferred a 8X – 24X mini, zoom binocular when sitting higher up in the bleachers. He may try the spectacle-mounted binoculars in the future. Mr. Jones also likes to take video of the game on his tablet computer, and enlarge the video at home so he can re-live certain parts of the game and have discussions with his son.
Take Home Message: Viewing the television, the flagstick and live football games are just a few examples of the numerous distance tasks that visually impaired people, like Mr. Jones, need to interact with on a daily basis. Helping patients determine proper viewing distances, screen sizes and optical and digital devices can significantly improve independence and quality of life.

Presented by the COA Low Vision Committee
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