

Assistive Technology for People with Low-Vision or Reduced Visual Acuity

The National Institute for Rehabilitation Engineering (NIRE) is an IRS section 501©3 charitable & non-profit organization which previously operated clinics for the development and dispensing of Assistive Technology (1967-1996). These clinics assisted *hundreds* of people having permanently impaired vision - with personalized optical and electronic aids, user training, and employment assistance. This paper discusses clinical methods and devices successfully used - plus the newest technologies to July 2003. Because the NIRE no longer operates vision clinics, the information is being made available with hopes that it may help vision-impaired people everywhere to function more comfortably and independently based on help from local service providers. *PERMISSION is granted to freely copy and distribute this © paper provided all copies are complete and unaltered with The N.I.R.E. clearly identified as the source.*

PURPOSE ... of this Paper

This paper provides *general information* about “Low-Vision” and “Assistive Technology” for people with *permanently reduced visual acuity*. Hereafter, **RVA** will be used as the abbreviation for: “**Reduced Visual Acuity.” During the many years the N.I.R.E. operated its low-vision clinics, there were also many other low-vision clinics throughout the country. Clinics were in just about every city. All used, and still use, similar methods and equipment to assist people with RVA.**

We recommend that people with permanent visual impairment be referred by their local ophthalmologists, at the appropriate times, to nearby “low-vision” clinics for assistive devices, and training for the activities of daily living and for help with work-related tasks. Low-vision clinical staff will recommend and help patients to evaluate various assistive devices before purchase, to prevent the purchase of costly appliances that later prove useless.

RVA, as a primary disability, reduces a person’s quality of life. RVA may sometimes be accompanied by other secondary visual impairments. **ALL LOW-VISION CLINICS can effectively help people with RVA** because their methods and materials are so standardized. *However, low-vision clinics differ from each other in experience with and willingness to use special personalized methods and devices for visual impairments other than RVA.* (For other impairments, some low-vision clinics may help more than other clinics.)

Helping Non-RVA Patients World-Wide: During the years this Institute operated low-vision clinics, most of our RVA patients resided near our clinics. Significantly, people with other types of visual impairments came to our clinics from all over the world. ***While this Institute no longer operates vision clinics, we do make available without cost, highly technical and detailed “How-To” papers (listed at the end of this paper) on Assistive Technology to help disabled people, their vision-care providers, and employers, to better deal with visual impairments ... other than RVA.*** We recommend that people having any of the listed impairments obtain copies of the appropriate papers to share with their local vision-care professionals. *The technical information in these papers may help local low-vision staff to better assist people with the non-RVA visual impairments.*

**“LOW –VISION” is the term widely used in North America to mean:
“Visual Acuity Significantly Less Than Normal ... even with corrective lenses.”**

One is said to have “Low-Vision” or “RVA,” when the best corrected visual acuity is 20/70 or poorer, because 20/70 or poorer visual acuity interferes with many activities of daily living and with safely driving an automobile.

A person is “Legally Blind” when the best corrected visual acuity is 20/200 or less. This is significant because people who are “Legally Blind” in the U.S.A. qualify for government paid rehabilitation services, tax credits and other financial benefits. *People who are “Legally Blind” should contact their local state office for “Blind Services” or “Vocational Rehabilitation” to register for and receive these benefits.*

“REDUCED VISUAL ACUITY” is the most frequently occurring low-vision symptom. It so greatly interferes with a person’s “*quality of life*” that early relief is sought so the affected person can continue reading, writing, working and (sometimes) driving. Reduced Visual Acuity (or RVA) is often age-related with a gradual onset beginning at age 55 or older, often - but not always - from “Macular Degeneration.” RVA can occur very early, particularly with genetically transmitted disorders ... or, it can develop at any age in conjunction with various conditions or diseases.

*One or more **Other Visual Symptoms** - such as blind spots (retinal scotomas), tunnel vision, night blindness, reduced color perception, etc. – may exist with or without RVA. In most cases where they co-exist, the RVA is the primary and most disabling problem and needs to be dealt with first.* Because RVA is most common and most disabling, all low-vision clinics are staffed and equipped to deal with it. However, some low-vision clinics do not always deal well with some specific “*other*” visual symptoms.

“LOW-VISION CLINICS” are located in or near almost every city because low-vision (RVA) affects so many people. These clinics often publicize their services in the media and through senior groups and organizations. Some are private practices and others are operated by non-profit organizations. ***Most “Low-Vision Clinics” specialize in providing special customized lenses, eyeglasses, optical aids, and electronic aids, to people with permanent “low-vision” (RVA). Many clinics do not provide a full complement of vision aids for problems other than RVA ... and these clinics do not provide primary medical eye care.***

MEDICAL EXAMS & REFERRALS by patients’ ophthalmologists are a “**must**” before going to a low-vision clinic. ***Why?*** Because some eye conditions causing RVA can be successfully treated to restore lost vision and/or prevent additional vision loss. Each patient needs to have the vision-loss problem diagnosed and treated ... before obtaining low-vision aids. A patient’s local ophthalmologist may treat the patient, develop corrective lens prescriptions and then refer the patient to a low-vision clinic or practice. In some cases, the local ophthalmologist may refer a patient to an ophthalmologist who is a “retinal” specialist or a specialist for some other eye disorder. Some RVA patients may be referred to a neurologist or a neuro-ophthalmologist. ***Remember, it is essential to have all possible primary medical eye care before accepting vision loss as permanent ... and before obtaining low-vision aids.***

COMMERCIAL VENDORS advertise products that can be ordered by visually impaired people from catalogs. These products may include low- to moderate- cost items such as telescopes, opera glasses, handheld optical magnifiers, and even (no Rx) high-magnification reading glasses. Also advertised are expensive hi-tech reading aids such as

closed circuit TV (CCTV) magnification systems costing from \$2500 to \$3600 each and offering full-color magnifications up to 60X. In addition, display screen magnifier products for computers are offered from \$39 to \$695.

Low-Vision Aids Must Be Matched and Coordinated for maximum usefulness. A long-term RVA person may have sufficient experience with these devices to be able to safely purchase by mail. *Most low-vision patients, however, should NOT purchase any assistive devices by mail – or even from a salesperson who visits – unless specifically recommended by his eye doctor, therapist or low-vision aids counselor.* Reason: these types of aids perform poorly if not integrated with prescription glasses and other vision aids, to be used by the same individual. **EXAMPLES:** (#1) a person with corrected visual acuity of 20/400 needs a CCTV electronic magnifier for use in home or office for extended reading. (He uses close-reading eyeglasses for brief reading while traveling.) If the CCTV is purchased after trials at a low-vision clinic and used in conjunction with appropriate prescription eyeglasses, only 8X magnification is needed. With this setting, the user sees 6 to 10 words at a time (depending on screen size). If the same person were to buy the CCTV system from a commercial vendor, without having it coordinated with the proper prescription eyeglasses, the CCTV would have to be set for 40X magnification. With this setting, the user can see only 1 to 3 words at a time which requires constant word scrolling and makes reading difficult. (#2) a person with better acuity (ranging from 20/100 to 20/200) might read using handheld magnifiers. But, for maximum benefit, the handheld magnifiers must be coordinated with prescription reading glasses. **SUGGESTION:** *Always go to a well equipped low-vision clinic for complete examination, visual task performance assessment, low-vision aids trials, and counseling.* **Note:** Some low-vision clinics dispense all needed aids, optical and electronic. Other clinics dispense optical aids and coordinate patients' referrals to commercial sales representatives for costly hi-tech electronic aids. Either way, the low-vision clinic staff ensures that all vision aids are properly fitted, coordinated and useful ...for each patient.

CAUSES of RVA ... these conditions are common among the many possible causes:

Macular Degeneration (Age-Related) is the most common RVA cause. The disease starts slowly and may affect one eye slightly before affecting the other eye. Patients who have routine eye exams usually are diagnosed earlier than those who wait until they first notice reduced visual acuity. Age-Related Macular Degeneration usually does not progress to total blindness. Untreated, visual acuity may decrease over several years to as poor as 20/800 corrected. Usually, side- or peripheral- vision remains normal. Until a few years ago, little could be done to stop progressive loss of central vision. Today, ophthalmologists are often able to slow, or even to stop, the continuing loss of vision. Several methods may be used depending on the type of MD the patient has. These may include laser procedures to seal leaks in the retina; the daily intake of certain vitamins or medications, and the use of eyeglasses with special lens coatings. *Assistive Technology devices are used after medical treatment to compensate for remaining acuity losses that limit a person's Activities of Daily Living.*

Macular Degeneration (Juvenile) is often passed genetically and becomes evident during childhood. Symptoms are similar to those of Age-Related MD except they begin earlier and last a lifetime. The juvenile form of MD is usually self-limiting, does not result in total blindness, and can be well compensated for most activities of daily living (ADL) ... with appropriate Assistive Technology aids.

Stargardt's Disease is passed via recessive genes and causes MD-like symptoms in some children and young adults. People with this disorder can sometimes have its progression slowed by medical treatment. *Stargardt's is often accompanied by retinal blind spots (scotomas). Total blindness does not usually result. Because blind spots are not identical in both eyes, their impact on vision is often less for people having fused, binocular vision. Best corrected acuity can deteriorate, over time, to as poor as 20/1200.*

Diabetic Retinopathy is a common cause of RVA. Usually, both eyes are about equally affected. The loss of vision is progressive in diabetics who are uncontrolled or are inadequately controlled. It is most important for diabetes to be diagnosed and controlled by a physician, and for diabetics to have frequent eye examinations by an ophthalmologist. Generally, the diabetic's visual loss is irreversible although, in some cases, eye surgery or laser treatments may help. The main visual impairment for most people with diabetic retinopathy is RVA. However, some also may have reduced ability to discriminate colors, retinal blind spots (scotomas) or reduced side vision. Some may experience reduced night vision.

Other Genetic Visual Disorders: Reduced Visual Acuity is common among people with certain genetic disorders such as **ocular albinism** and **achromatopsia**. Typically, such a patient might have a best corrected visual acuity of 20/100 to 20/200 with no retinal scotomas. People with either of these disorders are light-sensitive and often require tinted lenses to see comfortably in bright light. They respond well to low-vision aids of various types. Achromatopes are totally color-blind. This presents work problems when the job requires color discrimination. Assistive Technology can help with some color discrimination tasks, but not all.

Some Infectious Diseases can result in RVA due to retinal or neurological damage. Visual losses caused by infections can sometimes be arrested, limited or even partly reversed if diagnosed and treated early. People with decreasing visual acuity should not only see their eye doctors promptly; they should also have general physical exams and tests for possible infections. Toxoplasmosis, Cytomegalovirus and Herpes are examples of infectious diseases that sometimes cause RVA ... but there are many others, also. ***Prompt diagnosis and medical treatment is important to arrest, slow or (sometimes) even reverse vision loss.***

Diseases of ...or Injuries to The Eyes can result in RVA. One common example: *cataracts*, or clouding of the lens inside the eye. The patient's ophthalmologist can easily determine by simple tests whether surgical removal of the clouded lens and its replacement with a plastic lens, will restore normal or near normal vision. If so, then surgery will correct the problem without need for Assistive Technology. Similarly, *clouded, scratched, infected, or damaged corneal tissues* can result in reduced visual acuity. The cornea is the transparent membrane on the front of the eye through which all light rays must pass. Sometimes, damaged corneas can be repaired surgically or non-surgically. In other cases, only corneal transplants suffice. Because of the long waits to obtain donated corneas, some people will need and benefit from Assistive Technology vision aids while awaiting their corneal transplants. *Partially detached retinas* are another possible cause of RVA - and require immediate medical care to prevent rapid and severe progression.

Neurological Disorders may cause Reduced Visual Acuity. Some typical conditions are optic atrophy, optic neuritis, multiple sclerosis, stroke, etc. Some of these conditions are more

treatable than others. Such patients should be under the care of both a neurologist and an ophthalmologist. The conditions and symptoms can usually be recognized by the ophthalmologist who refers to the neurologist. However, treatments may need to be systemic and ongoing, by the neurologist. Because these diseases are often chronic and can be progressive, ongoing medical supervision is important even though one's vision can usually be helped significantly with Assistive Technology vision aids.

LOW-VISION – What is it? How does it affect everyday life?

Normal vision is defined to be in the range from 20/20 to 20/40 - with or without conventional eyeglasses. The first expression (20/20) means a person sees, at 20 feet, the same detail as seen by another person having normal acuity, at 20 feet. The second expression (20/40) means the person sees at 20 feet, the same detail that another person having normal acuity sees at 40 feet. Note: The person whose visual acuity is 20/40 has half the visual acuity of the person whose vision is 20/20. **DRIVING:** *Each state tests and licenses automobile drivers in the U.S.A. All states test and license people who have best corrected visual acuity of 20/40 or 20/50 in at least one eye. Some states test, road-test and license individuals whose visual acuity is as poor as 20/70 or 20/100 - but with special requirements such as the use of "bioptic telescopic glasses" and special training (and possibly with restrictions against night driving). Some states do not permit "low-vision" driving, under any conditions.* (In metric-measure countries, normal visual acuity is 6/6 ... which is equivalent to 20/20 because 6 meters equal approximately 20 feet.)

A person whose best corrected acuity (with ordinary lenses) is 20/200 sees at 20 feet, the detail a normally sighted person sees at 200 feet. This person has lost 90 percent of his normal visual acuity. He retains only 10 percent. If his acuity were 20/400 then he would have only 5% of normal vision. *Most states absolutely forbid any person from driving whose visual acuity is 20/200 or poorer – no matter what visual aids the person might have. The reason for such a policy is that accident victims have successfully won very large judgments against some states for having licensed "legally blind" individuals to drive (who were subsequently involved in accidents).*

People in Different Ranges of Visual Acuity are affected differently ... as to each person's abilities, methods, and vision aids for pursuing his "Activities of Daily Living". In this paper, we discuss the Assistive Technology (AT) for people in each of the various reduced visual acuity (RVA) ranges.

LOW-VISION AIDS – Introductory Descriptions

Multi-Tasking Vision Aids: Generally, people having mild acuity losses (i.e. 20/70 to 20/100) are better able to use a single multi-purpose pair of eyeglasses for many different tasks and activities. This is much like senior citizens with normal vision, wearing and using a single pair of bifocal or trifocal eyeglasses for their near, intermediate and distance vision. As the visual acuity lessens, multi-use eyeglasses become less and less feasible. Therefore, most people with more severe acuity losses (20/200 to 20/400; and 20/400 to 20/800; and poorer) require a specific vision aid for each specific task. One person may use 6, 8 or more different vision aids, each for different tasks. Following are descriptions of various vision aids.

Eyeglasses for Low-Vision: (#1) those that look like ordinary glasses, in appearance, to other people ... and (#2) those that differ from ordinary glasses in appearance, to others. Both

types are discussed in more detail in each low-vision acuity range. Low-vision eyeglasses in either or both of these appearance categories may be for near, intermediate or distance vision.

Low-Vision Reading Glasses: Two User Options. (#1) *Ordinary, inexpensive reading glasses*, good for people with visual acuity from 20/20 to 20/100, usually achieve needed print magnification by using stronger lenses. The person with 20/20 (normal) vision, might read with a newspaper held 14 inches from his face. To read the same size print with ordinary looking, but stronger reading lenses, the person with 20/100 vision might need to hold the newspaper as close as 6 inches from his face. With 20/200 vision, this distance might be as little as 3 inches from the face. Reading this close leaves no room for writing and it precludes viewing materials that cannot be safely brought that close to the face. (#2) Another option is the use of *glasses having “bioptic microscopes.”* These are miniature telescopes (called reading microscopes), projecting through the lenses, which are set to focus on objects at a set distance such as 14 inches. CONVENTIONAL READING EYEGLASSES are inexpensive, attractive looking and allow wide-angle viewing. They become disadvantageous when the face-to-page distance becomes too close for safety or comfort. BIOPTIC MICROSCOPE EYEGLASSES allow comfortable reading distance, with needed magnification, for people with moderate to severe acuity loss. *Disadvantages* are high cost, heavy weight, unusual appearance ... and narrow viewing angle that allows only one or two words to be visible. Reading must be done with constant eye and head movements to slowly scan each line of text, from left to right and from top to bottom.

Optical Magnifiers (for reading) are available in different forms. No matter which form, they need to be coordinated with appropriate prescription reading glasses. Magnifiers are almost always less useful if used without appropriate eyeglasses. The various magnifier forms include: (1) small handheld convex-lens magnifier which is held in the air about 3 inches above the paper being read – this becomes tiresome; (2) small convex-lens magnifier on legs, that rests on paper being read; (3) flat, grooved “fresnel lens” plastic magnifier sheet held above a page by hand or with legs – gives poor quality images and is not recommended; (4) solid glass half-ball that rests on a page or sheet and is moved by hand for reading – sharp, clear and highly recommended but limited as to amount of magnification; and (5) cylindrical tube multi-lens magnifier (microscope) that is moved across a page by hand. It can give up to 15x magnification but shows one word or less at a time as lines are scanned.

Controlled Area Lighting is necessary and helpful to many people with RVA. Some patients require bright, direct lighting for best vision. Others may be light-sensitive and require even, controlled area lighting at a somewhat dim level for best vision. Those who are very light-sensitive may need to wear tinted or gradient tinted lenses. They may benefit from wearing a hat with a brim or visor to keep overhead glare from the eyes, such as from sunlight, bright ceiling lights, etc.

Hand-held Telescopes (Monocular or Binocular) for Enhanced Distance Vision can be purchased at low cost from commercial vendors. Often, the user will carry the device on his chest, suspended from a strap around his neck. When it is desired to read a sign or visually confirm the number on an approaching bus, the user raises the telescope to his face using one or both hands. Hand-held vision aids can be used safely only while standing or seated – but *never while walking or driving*. Some expensive binoculars are auto focus but most have to be manually focused, which consumes valuable time. One cannot accurately estimate or judge distance through a monocular or binocular telescope.

Bioptic Telescopic Glasses for Enhanced Vision at Distance (or Near) ... are very expensive, typically costing from \$1200 to \$3500 and are available only from low-vision clinics or practices. They are, essentially, prescription eyeglasses that have multiple viewing ports, somewhat like ordinary bifocal or trifocal eyeglasses. They are called “bioptic” because the telescope is mounted on or thru the lens, as is the reading segment of a conventional bifocal lens. The “bioptic” device is tubular, approximately 1.5 inch long. It is a miniature telescope containing from three to five lens elements. Typically, it is mounted so that ¼” is on the inside of the lens, toward the user’s eye ... and the remaining length projects forward, outside the lens. Most are round on the inside (viewing surface) and on the outside (front lens) although a few 2x models are rectangular for wider angle magnified viewing. They are usually rated as to magnification power, i.e. 2x or 3x or 4x. When a bioptic telescope is set for distance viewing, this means it is set to focus sharply on distant objects. It is usually set to focus at 20 feet (for classroom or other non-driving uses) ... or at 30 to 40 feet if used for (legal) driving. The bioptic telescope for magnified distance viewing is usually mounted high on the lens so the user sees wide-angle, unmagnified images until he chooses to lower his head, raise his eyes and look thru the telescopes. If the telescopic device is set for reading distance (typically 12 to 16 inches) then the device is referred to as a “bioptic microscope.” Mounting locations often differ for the two. When used for close tasks such as reading, writing or using hand tools, the tubular microscope is usually mounted low, like a senior’s bifocal reading add lens. The person using a bioptic microscope lowers his head and raises his eyes, for distance vision, to look through the lens above (not thru) the microscope. Patients having fused, binocular vision are usually fitted with parallel telescopes (or microscopes) for each eye. Some patients who lack fused binocular vision are fitted with a telescope or microscope for just one eye.

Closed Circuit TV (CCTV) Readers have a movable platform for book or paper, a video camera with zoom lens, and a large screen video display – set up as a complete system on a desktop. The CCTV reader facilitates comfortable reading and writing at a desk, by people with very poor visual acuity (typically in the range 20/200 to 20/2000). Some models can be set for any degree of magnification from 2x to 40x or even 60x. Most desktop systems display images magnified, in full color on screen sizes from 17 to 21 inches, diagonally. *Some portable models are also available, most with smaller displays and without color. In the near future, portable large screen models will be available using flat display technology.* Typical costs for CCTV systems range from \$1200 to \$3800 each. A CCTV system is used on a desk or table and is very comfortable to use for both writing and reading. One can easily handwrite letters and checks using it. Because it displays colors, it is also excellent for reading magazines and books. **CAUTION:** *Buy a CCTV system only on the advice of low-vision clinic staff, fully coordinated with reading glasses. If possible, buy from the low-vision clinic or a local sales representative who can service it in the user’s home or office. Never buy by mail, and never buy without coordinated eyeglasses glasses from, and training by the low-vision clinic staff.*

Portable Electronic Image Magnifiers for Enhanced Vision are available at costs from \$2800 up. An eyeglass frame is worn that has a miniature video camera attached, B&W or color. Wires go to and from the eyeglass frame from a small electronics box (with batteries) worn on the belt. One or both lenses of the eyeglasses serve for both regular direct vision and video enhanced vision. The camera has a zoom lens which the user can control, and has auto-

focus so the images are always sharp. *While designed for distance vision, some models can also be used for intermediate distances and near, for reading and writing.* These systems are intended for people with acuity in the range from 20/200 to 20/800. They are new and not much is known as to how well they work or whether they are better than bioptic telescopic glasses. **CAUTIONS:** (1) *It is dangerous for people to walk while seeing magnified images. Unless these electronic magnifiers offer dual or "bioptic" viewing, they should not be used while moving.* (2) *Do NOT buy these devices except on the advice of low-vision clinic staff.*

Screen Magnification for Computers can be of great help to many people. Many versions of Microsoft Windows already have built-in, software for selectively magnifying the displayed screen images. (*On the Windows Program Menu, go to: ACCESSORIES / ACCESS / MAGNIFY to start the MS software.*) This software is most useful, generally, to people having visual acuity in the range 20/100 to 20/200 because it uses "dual-window" screen magnification. Generally, people with acuity of 20/300 or less, need screen magnifier software that uses "single window" magnification and, optionally, spoken output (called screen-reader function). These more powerful screen magnifier software utilities are available from third-party vendors at costs from \$39 to \$700 each. **CAUTIONS:** (1) *Do not buy OPTICAL MAGNIFIERS to place between user and PC display because the flat magnifiers degrade image quality too much.* (2) *Do use appropriate software screen magnifiers.* (3) *Rely on low-vision clinic staff to coordinate computer eyeglasses with screen magnification for each person, individually; recommend the appropriate screen magnifier and train the patient in its use. Proper computer glasses, for display and keyboard, lessen the amount of magnification required. This facilitates more efficient computer use.*

Enlarged Printouts from Computers: Screen magnification, as discussed above, enables a person with RVA to use a conventional computer with standard applications, as might a non-handicapped person. *If the computer is connected to an image scanner, then images that are scanned and saved can be viewed, enlarged, on the computer display screen. This procedure can serve some of the functions of a CCTV magnifying document reader and, unlike with a CCTV, the computer images can be saved.* Unfortunately, screen magnification software does not create large-type printouts which might be needed by the visually impaired worker. A visually impaired worker needing enlarged printouts, for his own work, must usually create two work documents: one in the standard format and size; and a second one that is similar except for enlarged type and images, for printing. The two images must be manually synchronized and separately saved. People needing to work this way need to be trained in the procedures, by the employers, computer maintenance staff, or by staff at the low-vision clinic, or at a PC user training school.

Reading Reference Papers (Magnified) While Using A Computer. This is important to many people with RVA. Therefore, it is useful to understand the different ways of accomplishing this feat. **Examples:** (#1) Editing text documents on the computer while reading separate, written reference documents not in the computer; or (#2) Entering data in a computer spreadsheet while reading separate written records and cancelled checks.

The PREFERRED METHOD involves the use of two entirely separate systems, near each other. One is a stand-alone CCTV real-time reading aid ... and the other is a computer, standalone or networked, with installed screen magnification software and large-bold keycap labels. This method is the most costly because the CCTV might cost \$2,800 and the computer system might cost \$1,500. (Total = \$4,300).

The LEAST COSTLY METHOD involves the use of a comparable computer system (\$1,500) with the cost of an added flatbed image scanner (\$350). (Total = \$1,850). *This system is so slow and troublesome it is not worth considering.* First, the reading of reference documents is far too slow because this scanner does not read in real time. Instead, each page has to be separately placed, scanned, saved, and displayed – all manual steps on the computer. Second, the computer must be multi-tasking for this to work – the scanning and document display functions are two separate tasks which must function at the same time and through the same processor and memory used to run and display the computer applications. Third, this method uses one display screen for viewing BOTH the reference documents AND the computer application screens. Either all the displayed screens need to be made smaller to fit on one screen or else the magnified display screen must be switched from one document to another to show one at a time, in full size. ***This method should be avoided!***

Visual Impairments Other Than RVA may co-exist with RVA or may exist alone, without RVA. Because these problems are mostly less disabling than RVA, and because they less frequently occur, many low-vision clinics have little experience dealing with them. Later in this paper, are listed a series of papers available from this Institute on many of these non-RVA visual impairments. The papers are highly technical to be helpful to low-vision clinic staff.

LOW-VISION AIDS – Typically Helpful for SPECIFIC ACUITY RANGES

“Acuity” as used herein, means the best corrected acuity, otherwise unaided, for the better eye.

Acuity Range 20/20 to 20/70 – This range denotes normal or near-normal vision. Ordinary corrective glasses should suffice for most tasks. In rare instances, the person may need a special vision aid for a specific task, possibly a work related function ... or use of opera glasses for watching a play or sports event at distance. **DRIVING:** *Some states require 20/50 or 20/40 or better corrected vision, in the better eye, for driving.*

Acuity Range 20/70 to 20/100 – For people in this range, optical aids prove useful and electronic aids are not usually needed. **READING** and **WRITING** are accomplished with normal-looking reading glasses. What is unusual is that the person’s face must be closer to the paper than is usual. Typical reading/writing distance might be 5 to 7 inches instead of the usual 12 to 14 inches. *Note: Some people use ordinary reading glasses plus a handheld magnifier – or a desktop stand magnifier – to maintain normal reading distance and posture.* **INTERMEDIATE DISTANCES** may require different glasses for different tasks. For example, different lens prescriptions are needed for reading/writing, for preparing foods at arms’ length, for gardening, for painting the house, etc. **Beginning with 20/70 acuity and continuing into the lower acuity ranges**, more separate eyeglasses and vision aids are needed by each person for different tasks ... instead of one pair of trifocals for everything, as used by seniors with normal acuity. **DISTANCE VISION** in range 20/70 to 20/100 may be aided for specific purposes by the use of ordinary opera glasses, telescopes or binoculars. *Caution: These distance magnifiers are unsafe to use while walking, moving or driving.* **DRIVING** is permitted in some states, with special vision aids and training – and with some restrictions.

Acuity Range 20/100 to 20/200 – For people in this range, optical aids prove useful but electronic aids may also be helpful. **READING** and **WRITING** are accomplished with thick-

looking reading glasses. The person's face must be closer to the paper than usual. Typical reading/writing distance might be 3 to 5 inches instead of the usual 12 to 14 inches. Some people use the close-reading glasses while traveling but use a CCTV electronic magnifier for reading and writing at home or at work. *Note: Some people may use ordinary reading glasses plus a handheld magnifier – or a desktop stand magnifier – to maintain normal reading distance and posture.* DISTANCE VISION may be aided for specific purposes by the use of ordinary, inexpensive opera glasses, telescopes or binoculars. *Caution: These distance magnifiers are unsafe to use while walking, moving or driving.* DRIVING is permitted in some states if best vision is under 20/200 in the better eye, with special vision aids and training – and with some restrictions. BIOPTIC TELESCOPIC glasses greatly benefit people in this range, especially when moving or driving. They are distinctive in appearance and very costly, however. COMPUTER SCREEN MAGNIFICATION (2x to 4x) may prove very helpful.

Acuity Range 20/200 to 20/400 – For “legally blind” people in this range, optical aids prove less useful and electronic reading/writing aids are usually more helpful. READING and WRITING can be accomplished, when traveling, with thick-looking reading glasses. The person's face must be closer to the paper than usual. Typical reading/writing distance might be 1 to 3 inches instead of the usual 12 to 14 inches. Some people use the close-reading glasses while traveling but use a CCTV electronic magnifier for reading and writing at home or at work. BIOPTIC TELESCOPIC READING GLASSES can be used for reading and writing at a comfortable distance but are expensive and provide only narrow-angle imaging. For people in this range DISTANCE VISION may be partly aided for specific purposes by the use of ordinary, inexpensive opera glasses, telescopes or binoculars. *Caution: These distance magnifiers are unsafe to use while walking, moving or driving.* DRIVING is forbidden in virtually all states if best vision is 20/200 or less, in the better eye (even with special vision aids and training). BIOPTIC TELESCOPIC GLASSES greatly benefit people in this acuity range, especially when walking or moving. They are distinctive in appearance and very costly. COMPUTER SCREEN MAGNIFICATION (4x to 8x) may prove very helpful.

Acuity Range 20/400 to 20/800 – For people in this range, optical aids prove less useful and electronic reading/writing aids are usually more helpful. READING and WRITING can be accomplished, when traveling, with thick-looking reading glasses. The person's face must be closer to the paper than usual. Typical reading/writing distance might be 0.5 to 1.5 inches instead of the usual 12 to 14 inches. Some people use the close-reading glasses while traveling but use a CCTV electronic magnifier for reading and writing at home or at work. BIOPTIC TELESCOPIC READING GLASSES can be used for reading and writing at a comfortable distance but are expensive and provide only narrow-angle imaging. For people in this range DISTANCE VISION may be partly aided for specific purposes by the use of ordinary, inexpensive opera glasses, telescopes or binoculars. *Caution: These distance magnifiers are unsafe to use while walking, moving or driving.* DRIVING is forbidden in virtually all states if best vision is 20/200 or poorer, in the better eye (even with special vision aids and training). BIOPTIC TELESCOPIC Glasses greatly benefit people in this range, especially when walking or moving. They are distinctive in appearance and very costly. COMPUTER SCREEN MAGNIFICATION (8x to 16x) may prove very helpful.

Acuity Range 20/800 ... and poorer – For people in this range, optical aids prove almost useless. They must depend on electronic CCTV reading and writing aids (set for 20x to 60x) ...with matched eyeglasses. READING and WRITING may not be possible when traveling,

even with thick-reading glasses, telescopes or optical aids. Some people use special portable CCTV reading devices while traveling. Others use flatbed print scanners, portable or not, that scan documents and read them aloud. These machines are designed for people who are totally blind and cost about \$5,000. For people in this range DISTANCE VISION may be partly aided for specific purposes by the use of ordinary, inexpensive telescopes or binoculars.

Caution: These distance magnifiers are unsafe to use while walking, moving or driving.

DRIVING is forbidden in virtually all states if best corrected vision is 20/200 or less, in the better eye (even with special vision aids and training). BIOPTIC TELESCOPIC GLASSES

generally do not benefit people in this range. However, newly developed **Electronically Enhanced Eyeglasses** may be helpful to some people. COMPUTER SCREEN

MAGNIFICATION (8x to 16x) is generally very helpful but a combination “screen magnifier” and “screen reader” should be used in the computer. This provides BOTH a magnified screen and speech output at the same time. *Acuity, 20/1600 or less, usually requires a person to be equipped and trained as if totally blind.*

Automobile Driving, Safe & Legal, may be possible for *some* people with reduced visual acuity (RVA). Certain factors separately and collectively determine the feasibility of a particular person being able to drive with RVA: (1) driver licensing regulations in the person’s state of residence; (2) how safely the person can consistently drive after receiving all needed vision aids and on-the-road driver training; and (3) how motivated the person is to drive safely; (4) how difficult traffic conditions are in his driving area; and (5) how much stress he is willing to live with each day while driving. *If one is to drive, he or she should drive frequently and regularly to maintain driving skills. (Infrequent driving often leads to dangerous driving!)*

In most states that allow low-vision driving, driving privileges are generally limited to people whose best corrected visual acuity is 20/180 or better with ordinary eyeglasses ... and whose peripheral vision is normal. (Usual acuity range: 20/70 to 20/180). In addition, these states usually require use of “biotic telescopic glasses” such that, through the telescope, the user can read distant signs at 20/40 acuity or better.

To determine if safe and legal driving is feasible, a person with low-vision should consult a local low-vision clinic and a local driving school having experience with low-vision drivers. *Low-vision driving has been becoming more difficult and hazardous each year as highway congestion and driving speeds have steadily increased. Fewer people with reduced visual acuity desire to drive nowadays ... than desired to drive 10 years ago.*

TECHNICAL PAPERS about OTHER VISION DISABILITIES (not RVA) are available from the N.I.R.E. as listed below. These papers contain both general information for patients *and* technical information for their vision-care professionals. The papers can be requested by e-mail or by regular mail. They are available in print, on disk, or from the internet. **Please contact The N.I.R.E.**

"Helping People Who Have Double Vision (Diplopia)"

"Vision Aids for People Having Homonymous Hemianopsia"

"Vision Aids for People Sighted in One Eye"

"Functional help for People Having Retinal Scotomas"

"*Eyeglasses for People With Vertical Eye Movement Disorders*"
and/or Ambulation Disorders - from PSP* or Parkinsonism
(*PSP = Progressive Supranuclear Palsy) – paper *also discusses...*
"*Eyeglasses for People Missing Lower Halves of Visual Fields*"

"Vision Aids for People with Impaired Color Perception"
"Information About Impaired Night Vision & Night Blindness"
"Optical Aids for Impaired Peripheral Vision ... or Tunnel Vision"

Future Developments ... now being researched

At the time of this writing, some exciting new clinical research developments are being planned or tested for helping people who are totally blind or very near to totally blind. ***Among the more promising research projects are these:***

- (1) Transplants of good retinal cells from donors, to replace dead and dying cells.
- (2) Transplants of whole eyes from donors to blind recipients.
- (3) Stem Cells to re-grow ocular and/or intra-ocular tissues. Unfortunately, this is being delayed by government policy intended to limit stem cell therapies.
- (4) Implants of electronic retinal or optic nerve stimulators within the eye to provide artificial vision to people who may otherwise be totally blind.
- (5) Artificial Vision using a TV camera to feed live, moving images directly to the brain's occipital cortex in real time, using implanted electrodes.
- (6) Gene Therapy to correct problems caused by defective or damaged genes. This has been used successfully to help people with specific life-threatening genetic disorders. The next step is to develop gene therapies for genetic visual disorders.

Some of these research trials are already working in human test subjects and are being monitored for functional results and long-term effects. The research is being done in different countries throughout the world, and blind people have been helped.

For additional information or free technical support, please email: nire@warwick.net or contact us by regular mail or telephone.

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