Visual Distance Perception & Depth Perception

Improving People's Perception Skills with Optical Aids and/or Training
... for *Specialized Occupations, Safer Driving and Safer Use of Machinery*

The National Institute for Rehabilitation Engineering (NIRE) is a non-profit organization which operated clinics for the development and dispensing of vision, mobility, and communications aids (with user training and job placement services) from 1967 through 1997. These clinics specialized in the application of "human factors engineering" and "task-performance training" to help permanently handicapped people to function more efficiently in their activities of daily living and in their work duties. The NIRE assisted *hundreds* of people having permanent visual and/or other physical impairments. This paper discusses the characteristics of **Visual Distance- and Depth- Perception** as experienced by people having normal vision in each eye, with normal fused binocular (stereoscopic) vision ... and of other people having visual impairments of either or both eyes. The purpose of this paper is to help people who have **"Reduced" Distance and/or Depth Perception** to understand and to improve their distance and depth perception skills with lenses and/or training in order to drive or to perform other types of tasks more safely and more efficiently. Because the NIRE no longer operates these clinics, the information is being published so that NIRE's methods and data can be used by health-care professionals all over the world, to assist disabled individuals.

Overview of Topics

Although based partly on published scientific research findings, this paper is mostly based on performance data in this Institute's clinical files, from 1967 through 1995. Many of our clients were visually impaired drivers whom we fitted with special eyeglasses and trained. During this period, our low-vision staff worked with some visually impaired surgeons to help them to read x-rays and to perform both conventional surgeries and remote surgeries with real-time electronic imaging. Our staff also worked with veterinarians and animal trainers to select helper animals for disabled people, with personalized training of the humans and their animals. These helper animals were for blind people, for deaf people, and for paralyzed people such as quadriplegics.

HUMAN DISTANCE - & DEPTH - PERCEPTION ABILITIES are important in many aspects of our daily lives. How do we humans perceive distances and depths? What variations exist from person to person? And how significant are these variations to our everyday lives and to the public safety?

HIGHWAY SAFETY requires that drivers of automobiles, buses and trucks be able to accurately and instantly judge distances ... ahead, to the rear and to the sides. Failure to do so can lead to accidents. It is well established that people with good vision in both eyes are able to judge distance accurately using their stereoscopic binocular vision. But, what about people sighted in only one eye? Or people having good vision in one eye and poor vision in the other eye? What about people with poor visual acuity in both eyes who drive using bioptic telescopes or other low-vision aids? *This paper addresses these questions and discusses ways of enhancing the Distance- and Depth- Perception abilities of people with vision impairments.*

REMOTE CONTROL SURGERIES may be performed on patients located nearby ... or hundreds, or even thousands of miles away ... using "Robotic" remote-control surgical systems with flat 2-D video displays, to view and cut and seal a patient's internal tissues.

What are the vision requirements for surgeons using these display systems, to ensure safe and accurate surgeries? *Can the 2-D video imaging and visualization methods used by these surgeons also be used advantageously in other fields? Do these methods work as well for monocular surgeons as for binocular surgeons? What about surgeons having other vision impairments?* What about surgeons using older (non-electronic) optical scopes?

ANIMAL HELPERS FOR THE DISABLED have vision characteristics very different from those of humans. How do animals of various species see? *Which animals are most- and least- suitable, in terms of eyesight, to act as helpers or aides to human beings?*

TERMINOLOGY

"Distance Perception" is the all-inclusive term for seeing and recognizing distances between people and/or objects in any and all directions relative to a viewer's eye. It is the ability to view objects near to far, and at varying angles, and to be able to accurately and quickly estimate: (1) distance from a person's eye to a particular object; and (2) distances between specific objects no matter what the directions and distances (outward from viewer's eye, left-to-right distances between objects).

"Absolute Distance" is the exact distance in inches, feet or yards, between the viewer's eye and an object, or between observed objects. **"Absolute Size"** is the exact size of an observed object, in inches, feet or yards.

"Relative Distance" is the relative distance of observed objects, i.e. "the blue car is halfway between my car and the red car." **"Relative Size"** is the relative size of each of two objects being observed, i.e. "... If the green car is seen to be half the size of the black car, then it must be twice as far from me." Or "... If both cars are the same size, then the green car must be farther from me than the black car. How far is each car from me?" The viewer always needs to, in his mind, coordinate the relative sizes if, and the distances of observed objects.

"Depth Perception" has very specific and limited meaning. This is the distance straight ahead of the viewer's eye, toward or into an object or surface. By definition, depth is looking straight into a hole or tube and estimating forward distances. Doing this accurately requires binocular stereoscopic vision (stereopsis) and may be more difficult or less accurate for people lacking stereopsis. Their depth vision must rely on visual cues other than stereopsis.

"Binocular Stereoscopic Vision" or **"Stereopsis"** indicates that a person is seeing clearly with two good eyes; that the images from the two eyes are fully fused, and that he has stereoscopic vision ... which helps the person to more quickly and accurately judge distances. *People who see with just one eye lack this tool. People having normal vision in*

one eye and reduced- or low- vision in the other eye, either lack this tool or have it in reduced form. Most animals lack stereoscopic vision.

Distance "CUES" enable a person to perceive distances and sizes. People with normal binocular vision use cues not available to others: (1) wrapping-around of objects due to the distance between the eyes; and (2) tensions in the eye rotator muscles which converge the eyes on an object and which vary tension with distance. Other observation "CUES" help all, even people with impaired vision, include: (a) relative object sizes; (b) object distal end taper; (c) angular variations; (d) tensions in the eye, of the focus muscles, that vary with object distances ; and (e) luminosity and shading variations. These and other cues are described in detail in "The Notebooks of Leonardo DaVinci" a noted artist and engineer who lived in the middle ages. ("These are sold in bookstores.)

HUMAN VISION – with two normally functioning eyes

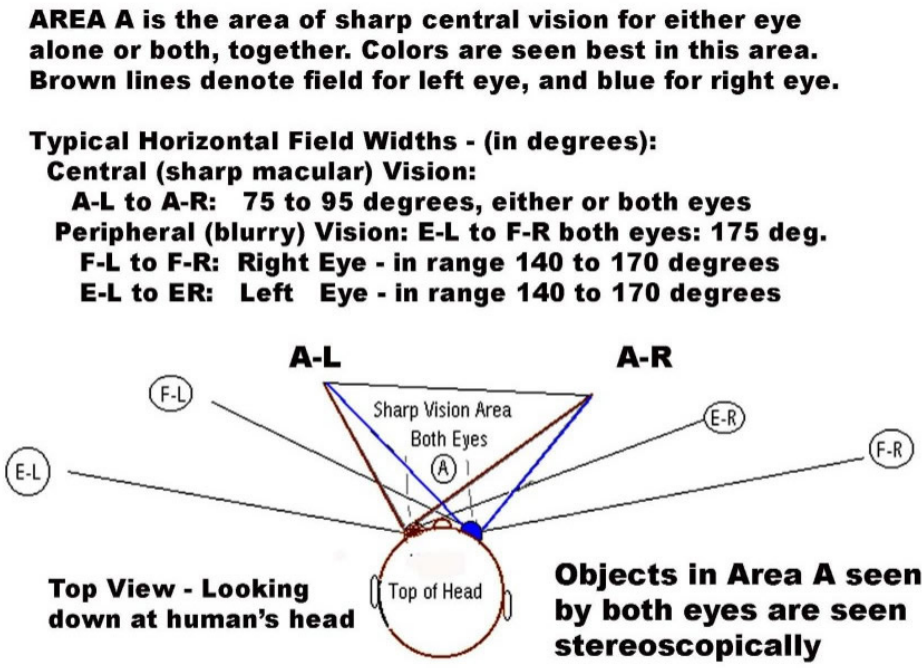

Figure 1: Visual Fields with Normal Vision in Both Eyes

Human vision is unique among all the species and it, alone, gives us a full range of benefits lacking in other species. As with most animals, we humans have wide-field **peripheral vision** which protects us from attacks, collisions and accidents (typically over an angle of 175 degrees). Unlike most animals, we humans have a large area (85 to 95 degrees wide) of **sharp, clear vision**, typically rated 20/20). Unlike most animals, we see **a full range of colors** and color intensities. And, unlike animals, we see a fused binocular, stereoscopic image with both eyes, which enhances our distance- and depth-perception abilities. As with most animals, the retinal "rod" cells that give humans wide-angle peripheral vision also give us good night-vision, even in very dim light.

These descriptions of human vision apply when both eyes have normal functioning, in all

respects – unaided or aided with lenses. When one eye or both eyes have less than normal functioning, then some of the advantages of human vision may be lost, including those relating to distance- and depth- perception. When such deficits are present, they can be measured and often can be compensated with training and/or vision aids. *It helps to know how animals perceive distances without their having binocular stereoscopic vision.*

ANIMAL VISION – typical ... with two normally functioning eyes

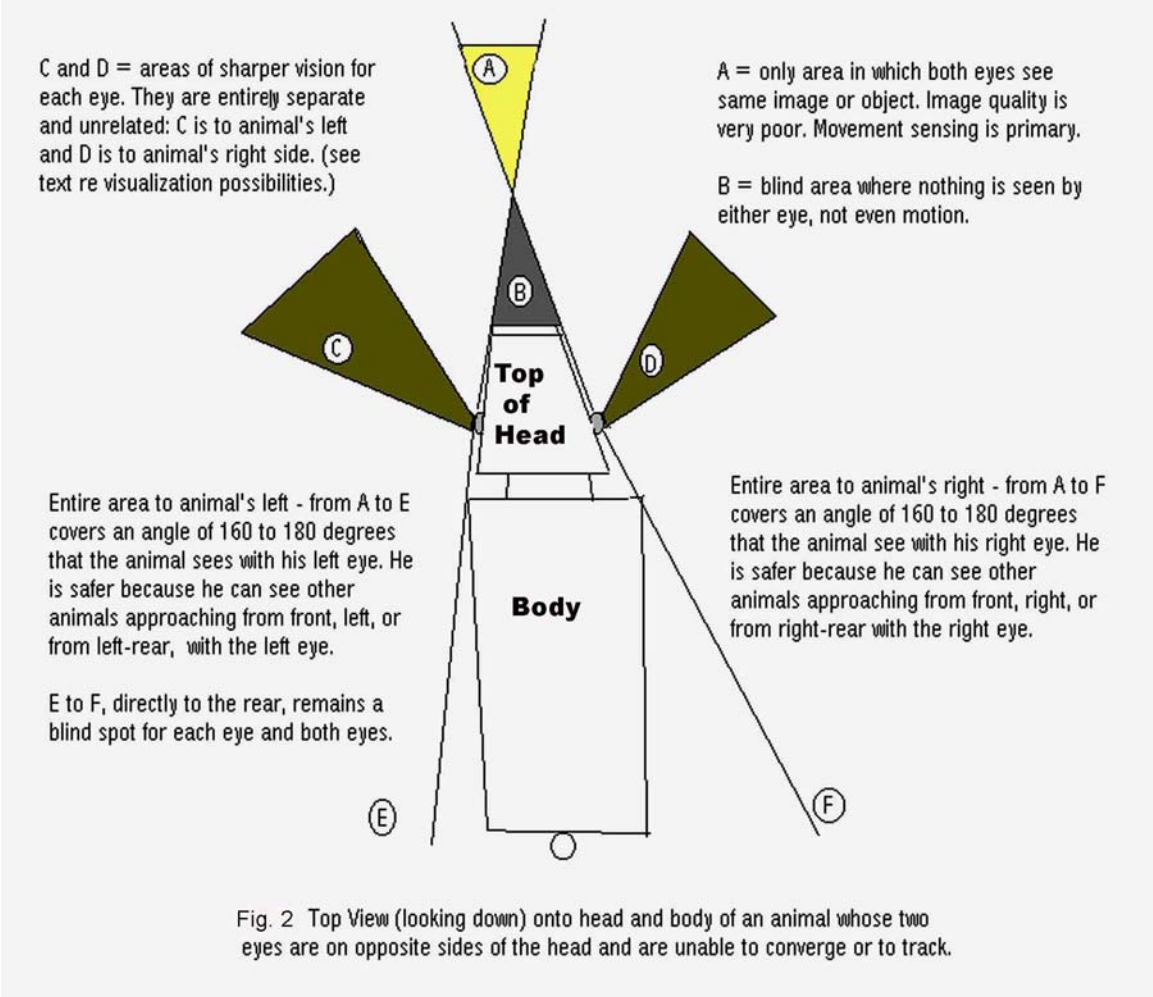

Figure 2: Top View (looking down) onto head and body of an animal whose two eyes are on opposite sides of the head and are unable to converge to track.

The animal shown is a horse or other **large four-legged animal** with eyes on opposite sides of the head, facing outward and not converging.
We separately discuss the vision of animals whose eyes partially converge.

In FIG. 2 above, **Area A** is ahead of the animal and is seen with both eyes at the same time. The overlapping fields that create Area A are at the fringes of peripheral vision and provide such poor acuity as to preclude any type of stereoscopic distance perception. **The animals depend on their sense of smell to locate, identify and avoid (or eat) nearby**

objects, foods, or materials. They also rely heavily on their hearing - which is more acute than that of humans.

Area B is a blind area cause by blockage of vision by the animal's snout.

Areas C and D on the animal's left and right sides, respectively, are areas of greatest acuity. Note these areas may be only 30 to 45 degrees wide, each ... and are much narrower than the 85 to 95 degrees in humans. At best, in these "sharp vision" areas, acuity might be the equivalent of 20/200 – not nearly as useful as a human's normal central acuity of 20/20. **Vision in these higher-acuity retinal areas provides some useful distance perception and is very helpful to horses on the race track, and to horses, cattle and other large animals that travel in herds.**

The left- and right- side peripheral vision areas, A-to-E and A-to-F, are each almost 180 degrees wide, with one on each side, from front to rear. Visual acuity within these areas is thought to vary from 20/200 to 20/800. Animals with two normal eyes do see with both eyes at the same time. Their brains align the two images side by side for one continuous field. This works for the animals because the two fields are low-resolution rod cell (peripheral) images which do not need, and could not be fused into a single, sharp, stereoscopic image –as with humans.

These vision characteristics have enabled the animal species to survive because, with the eyes positioned as they are, and the vision characteristics as described, the animals can see, at all times, all around themselves (except for behind the tail). They don't need rear-view mirrors.

IN THE MID-1980's, a low-vision client of the N.I.R.E. – a lawyer whose vision was so poor that he could never drive safely or legally – asked for a **"Seeing Eye Horse."** He lived and worked in a densely populated high-traffic suburban area and wanted a horse he could ride on the streets that would be trained as both a riding horse and a "Seeing Eye" animal. At this man's request, we explored: (1) A horse's vision characteristics, (2) A horse's trainability as a "Seeing Eye" animal, (3) Whether or not a horse can safely walk, trot or run in automobile traffic without blinders on his eyes and without a sighted rider to guide him, (4) Whether or not a horse could be trained to walk, trot and run safely in traffic, using his own judgment, without human guidance; and (5) If everything appeared favorable, would the police allow a horse to navigate itself, using its own judgment, on the streets and highways?

By the time we had completed our research into questions 1 through 3, the client had passed away so that we never completed work on 4 and 5. But we did learn a lot about horse vision.

Animal NIGHT VISION is usually quite good over all visual field areas because almost all the retinal cells are "rod" cells which provide both peripheral vision, day and night ... and night vision.

Animal COLOR PERCEPTION is very poor, as is their visual acuity. Colored objects appear mostly in varying shades of gray. The reason is that the central areas of animal retinas contain only 15 to 20 percent of "cone" cells which are the cells that see colors and yield sharp daytime vision, in humans. The central areas of the human retina contain almost 100 percent "cone" cells. (The animal rod percentage numbers were reported by veterinarians and biologists from post mortem retinal tissue studies.)

Humans born with "achromatopsia" have greatly reduced visual acuity and little or no color perception ... their retinas and vision are very similar to animals.

ANIMAL VISION – Smaller Animals ... with near-parallel eyes

Many animals with smaller bodies, shorter snouts and flatter faces have eyes that may or may not be parallel-tracking (as with humans) but which have partial convergence. A lot of work has been done with "Seeing Eye" and "Handicapped Helper" dogs. Their color sensing and distance perception weaknesses, and poor best-case visual acuity ratings, are similar to those for larger animals as discussed above. The major differences are that the best-acuity areas are more toward the front, and less to the sides, than as shown in Figure 2 for large animals. Some of these smaller animals can see more clearly ahead and may have larger areas of overlapping vision.

As with large animals, dogs and cats depend on acute senses of smell and hearing to detect, locate and identify approaching dangers. Most animals have very much more sensitive **hearing** than humans, and hear over a much wider frequency range than humans.

Animals almost universally use their sense of **smell** (not vision) to recognize people, foods and various objects. The sense of smell is so sensitive that most animals can identify the humans who may have previously handled objects. Next, they rely on hearing ...and then on vision.

Some land, sea and airborne animals use their own biologic sonic (passive) or sonar (active) ranging systems for perceiving distances. Flying bats, some birds, and some sea animals are known for such functions.

As with large animals, the smaller animals, immediately see and track **moving objects** or animals. Using their retinal "rod" cells, animals are very aware of other animals, insects and objects that are moving ... in front of them or to either side. They are less aware of objects moving directly toward or away from them ... and are more aware of objects moving across their visual fields. These animals have some "Distance Perception" but little to no "Depth Perception."

Monkeys trained to be "Helping Hands" to quadriplegics appear to have vision characteristics closer to those of humans than to those of other animal species. While it is difficult to train and live with monkeys because of their frequent behavioral problems, their human-like vision and dexterous hands make them very desirable for this work.

Monkeys seemed to have had much better distance- and depth- perception abilities than most other animals.

HUMAN VISION – with various vision impairments

TABLE 1. The table below indicates the Distance Perception Abilities of people with each of various combinations of vision impairment. Further details are discussed in the paragraphs that follow the table.

Left Eye acuity	**Right Eye acuity**	**Left Field width**	**Right Field width**	**Distance Perception ability**	**Distance Perception sensing clues**
20/20 to 20/40 Normal	**20/20 to 20/40 Normal**	**140E or better Normal**	**145E or better Normal**	**Good** with stereopsis **Normal**	• **stereopsis** • relative size • object shading • relative distance • head movement
20/20 to 20/40	No Light Perception	142E or better	0E Blind right eye	**Good** even without stereopsis	• relative size • object shading • relative distance • head movement
20/20 to 20/40	20/200 or worse	140E or better	138E or better	**Poor** as is. Better if right eye is Patched	• relative size • object shading • relative distance • head movement
20/200 or worse	20/200 or worse	140E or better	140E or better	**Very Poor** for non-moving objects	• relative size • relative distance • head movement
20/20 to 20/40	20/20 to 20/40	50E or less tunnel vision	50E or less tunnel vision	**Good** with stereopsis in central vision	• **stereopsis** • relative size • object shading • relative distance • head movement

One Eye with Normal Visual Acuity – and The Other Eye Totally Blind

This person, lacking light perception in the poorer eye, sees clearly and without distractions using his one good eye. And, despite being without stereopsis, he quickly learns to accurately and quickly perceive distances of people, objects and vehicles. This truly monocular person usually has an overall field-of-vision width or 140 degrees or more ... more than enough to drive safely.

All states license monocular people to drive passenger automobiles. Some states do not license them to ride motorcycles or to drive large trucks. Some states do so, but after only special, very rigorous road tests.

The U.S. Department of Transportation (DOT) did, for years, withhold interstate truck driving certifications from even experienced drivers who became monocular. The agency claimed they did this, more out of concern for accidents resulting from the lack of stereopsis, than for concerns about the small reduction in overall field-of-vision width that occurs with monocular vision. *Heavily loaded trucks, when driving at highway speeds, require early braking decisions because of the excessively long braking times needed. The DOT felt that driver distance-perception sensing data were not adequate, without stereopsis, to ensure good judgment and early braking decisions.* This theory has never been researched, tested or proven. Therefore, many drivers, their unions and their employers feel this policy in unwarranted and unfair. They feel, and we tend to agree, that drivers who are, or who become monocular, should be rigorously road tested to determine in each instance, if the driver should or should not be certified.

One Eye with Normal Visual Acuity – and The Other Eye Partially Blind

State licensing and federal certification policies for truck drivers make little distinction between "totally" monocular drivers ... and other drivers who have "Normal Vision in One Eye – and Impaired Vision in the Other Eye." In general, state licensing rules for driving automobiles treat these people the same way they treat those with one normal eye and one totally blind eye.

The federal certification officials usually treat those with partial sight in one eye exactly the same as they treat drivers totally blind in one eye.

TOTALLY MONOCULAR DRIVERS - This Institute's many years' experience in on-the-road testing, evaluation, and safe-driver training of visually impaired people has repeatedly confirmed that almost all TOTALLY MONOCULAR people can drive with complete safety, with normal driver training, normal prescription eyeglasses, and normal rear-view mirrors.

PARTIALLY MONOCULAR DRIVERS – This Institute's many years' experience in low-vision clinical work and on-the-road testing, evaluation, and safe-driver training of visually impaired people has repeatedly confirmed that some PARTIALLY MONOCULAR people cannot drive with complete safety, *with ONLY normal driver training, normal prescription eyeglasses, and normal rear-view mirrors.* With many of these people, the poor quality image from the bad eye is superimposed by the brain on the sharp, clear image seen by the good eye. In these instances, the sharp vision is degraded by the blurred vision of the bad eye. These people should always be tested for this. Whenever it is found to be a problem, these remedies are available:

1. **Vision Trainers** (ophthalmology assistants or optometrists) can train some people's brains to ignore the low quality image from the bad eye, and to not superimpose it on the clear image. For some patients, the bad eye images are totally suppressed and unseen. Other patients can be conditioned so the blurred central vision images are suppressed while the outside peripheral (side) vision is kept active on the poor-vision side. **Or else ...**

2. **Eye Doctors** can prescribe and fit a contact **lens**, or an eyeglass lens, to occlude and block the unclear images of the bad eye so they are not superimposed on the sharp image from the other eye. The special lens (contact or spectacle) can be **partially occluded** ... **or totally occluded**. If partially occluded, the blurred central area images are blocked but peripheral or side vision is retained. If the poorer eye is totally occluded, then peripheral or side vision is also blocked and the person learns to function as a TOTALLY MONOCULAR DRIVER while wearing the occluder.

Our experiences have repeatedly confirmed that PARTIALLY MONOCULAR PEOPLE should be evaluated and assisted as described above, to be better and safer drivers. Once trained for image suppression or given occlusion lenses, they quickly become more proficient at distance perception and safe driving, with regular practice.

DISTANCE PERCEPTION TESTING – for newly Monocular People

Stereoptic Testing Machines cannot be used because, by definition, monocular people cannot see adequately with both eyes as necessary to use such devices. Other indoor test devices can be used, including personal computers and 2-D / 3-D video games, so long as they can be seen and used by both totally- and partially- monocular people.

NIRE's staff did use indoor laboratory test devices for fast screening purposes. However, the preferred evaluation and training methods included real-life activities such as: (1) playing pool or billiards, shuffleboard, croquet or miniature golf; (2) driving miniature electric cars (such as used in amusement parks) in close quarters ... or driving golf carts in close quarters on a test course; and (3) maneuvering and parking an automobile in close quarters; etc. Some people improve their distance perception skills, generally, after learning to draw and paint in perspective. Drawing and painting classes are available in most areas and can be very helpful.

LOW-VISION (Reduced Acuity) with **Normal Visual Fields**...
and DISTANCE PERCEPTION

When both eyes have reduced visual acuity (that is 20/100 or poorer), the person's distance perception abilities may decrease because some of the incoming distance cues may not be recognized and or be properly interpreted. Low vision aids such as hand-held, or eyeglass-mounted telescopes improve the person's ability to see detail (functional acuity) whether for one- or both- eyes and thus may also improve distance perception.

People cannot safely drive using a hand-held telescope. However, some states license low-vision (reduced acuity) drivers who use "bioptic telescopic glasses." People with such glasses move constantly move their eyes up and down, between an unmagnified area of the lens, and the eyepiece of the miniature telescope. The person mostly views the world ahead directly, although without sharpness, not using the telescope. In this mode, he sees the largest possible area and can judge the distances to and between large, visible (to him) objects. His momentary glances at the telescope allow him to momentarily see image details that would otherwise not be visible to him. He learns to mentally

superimpose these observed details on the directly viewed, blurry, scene. Most bioptic eyeglass users do not have the distance- judging benefits of stereopsis, even if they use two telescopes, one for each eye. For these people, no advance prognostications can be made relative to their safely driving. Each such person must undergo training and testing until he qualifies or gives up trying.

REDUCED PERIPHERAL VISION with **NORMAL ACUITY**...
and DISTANCE PERCEPTION

As long as one eye, or both eyes, has normal visual acuity, the person's distance perception abilities should be the same as that of any other normally sighted person, or any person with normal acuity in at least one eye. The loss of peripheral vision should not, in itself, lessen distance perception abilities. Driving is a concern, because of the narrow or reduced visual fields, not because of distance perception problems.

Tunnel Vision can result from the progression of glaucoma or retinitis pigmentosa. Even with good acuity, people having a total field width of less than 90 degrees should not drive. With the field width between 90 and 120 degrees, some of these people can learn to drive safely using non-minifying field expander glasses and special rear-view mirrors on the car. People with field widths of 135 degrees or more, can usually drive safely using ordinary glasses and rear-view mirrors – but they must learn and use visual scanning techniques. People with tunnel vision often have night blindness because of the loss of rod cells in the retina.

Hemianopsia - Homonymous, Monocular, Bi-Nasal, or Bi-Temporal - often leaves a person with a field width of 90 degrees for each eye. **"Hemianopsia"** means that the eye has lost its side (peripheral) vision toward one side. **"Homonymous Hemianopsia"** or HH, denotes that both eyes are affected the same way i.e. both eyes are blind to the left ... but see to the right, or visa versa. **"Monocular Hemianopsia"** or MonoH, means the person sees with one eye and that same eye is blind to one side. **"Bi-Nasal Hemianopsia"** or BN**,** means each eye is blind toward the nose, leaving a blind area or tunnel in the center of the sharp-vision area. **"Bi-Temporal Hemianopsia"** or BT, means each eye is blind to its outside; i.e. left eye is blind to the left and right eye is blind to the right. This leaves the person with something akin to reverse tunnel vision: a tunnel of sight surrounded by a tube of blindness.

Some of these people won't want to drive, but others are determined to drive safely and legally. Some states will allow it if the driver passes rigorous road tests. Other states do not allow hemianopes to be tested or to drive. Some hemianopes who are determined to drive, can learn to do so safely using non-minifying field expander glasses, special 180 degree non-minifying rear-view mirrors, and special visual scanning and safe-driving techniques. People with hemianopsia sometimes have night blindness because of the loss of rod cells in the retina.

Hemianopsia is not an eye disease. It results from brain injuries, strokes or blood clots. Sometimes, the same incident that caused the hemianopsia also cause losses of short-term memory, or slower reaction times; slower reflex re reactions. For these other reasons,

quite apart from the hemianopic vision, some people with hemianopsia should not drive. The stroke or blood clots that caused the onset of hemianopsia occasionally disrupt a person's fused binocular stereoscopic vision when both eyes still have normal acuity. Thus, the hemianope's distance perception skills may vary in unexpected ways over time.

2-D and 3-D ELECTRONIC IMAGING DISPLAYS ... and Distance Perception

For years, physicians have been using optical endoscopes for both internal examinations and certain types of surgery. Some of the scopes have optical eyepieces similar to those on telescopes and binoculars. With these, the surgeon looks directly into an eyepiece and only he can see the real-time images.

Many newer scopes display their images on electronic video display screens. Some use a single video screen that displays flat, two-dimensional (2-D), images. Others use multiple displays for simultaneously displaying views from different angles or perspectives. These techniques for internal organ examinations and surgeries have proven so efficient, useful and safe, that surgeons in Boston, MA (USA) have successfully operated on patients as far away as Paris, France using "Remote Robotic Surgical Systems." The patient is in an operating room in a far away place, with a local surgical team that is complete except for the specialist (brain, cardiac or other) surgeon. Robotic, remote controlled surgical instruments are in place at the site of the surgery, and all are linked by reliable satellite communications to the far-away specialist surgeon.

While observing the operating room, the patient's exterior views, the local surgical staff, and the patient's internal organs on separate 2-D video displays, the surgeon (in constant two-way voice contact with the operating room staff) manipulates dials and handles that directly control and operate the scopes and scalpels inside the distant patient. It has been found that 2-D displays are entirely satisfactory so that binocular, stereoscopic (3-D) viewing is not necessary. Similarly, because 3-D viewing is not needed, it makes little difference whether or not the surgeon has binocular stereoscopic vision. *But, yes**, accurate distance- and depth- perception are absolutely necessary for these surgeries.***

This topic is of interest because the visual scenes which require precise distance- and depth- perception (without stereopsis) are electronically rotated by computers, in any of three dimensions, so that the surgeon can view, compare and measure any or all elements in his flat views. *Unfortunately, drivers cannot drive while viewing rotated or altered views of the road and nearby traffic.*

The required accuracies of distance- and depth- perception are largely achieved by the surgeons using computer controlled displays, in two ways.

1. **DISTANCE PERCEPTION** accuracy is achieved by viewing flat, linear top- and side- views such that direct size comparisons are possible. Ruler markings can be included in or be superimposed over the displayed images.

2. **DEPTH PERCEPTION** or viewing directly ahead in a tube and estimating distances ahead, is very difficult to achieve, with or without stereopsis. The computer controlled surgical display and control systems can superimpose on straight-ahead (or in-out) views, ruler markings that accurately indicate depth or distance.

CONCLUSIONS

Distance- and depth- perception are skills learned through repetitive practice. Normally-sighted, binocular and totally monocular people most easily develop and use these skills. Visually impaired people, binocular or monocular, often – but not always – develop effective distance perception skills. Therefore, it is recommended that people needing good distance perception abilities for hobbies, work or driving, be given every possible opportunity to practice and develop these abilities ... that and they be individually tested when necessary ... for safety reasons.

RESOURCES ... for Assistance with Distance- and Depth- Perception

Ophthalmologists, optometrists, opticians, vision trainers, mobility trainers, safe driving instructors, and sports trainers (for golf, tennis, marksmanship, etc.) can often be helpful to people with poor distance perception.

Office visits may not be enough. Some people are best helped if evaluated and trained in the actual environments where difficulties are being experienced, on the job or on the road. Some professional grade computer driving or flight simulators can be helpful. But others, notably, games for entertainment, are scaled improperly and thus useless or detrimental for distance perception practice exercises.

For additional information or free technical support, please email:
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