Binocular Vision and Related Conditions

Binocular Vision
Stereoscopic Vision
Strabismus
Amblyopia

Binocular Vision

Definition: Binocular: adj.: the simultaneous use of both eyes, two-eyed or two-sights.

That's just the beginning of the story. When most people hear the word “binocular” they envision a compact, hand-held, two eyepiece telescope used to watch birds, or whales or whatever. Magnifying and viewing distant objects as if you’ve been transported there is the function of this optical device. The optical and vision related definition of “binocular” involves a number of functional properties of the human vision system and visual perception.

Stereoscopic imaging and depth perception

Binocular vision requires two views of an object, each seen from a slightly different angle (parallax) combined to form a three dimensional (stereoscopic or “3-D”) presentation of that visible space. Our eyes are placed some distance apart, with a divider (the nose) in between, creating the ability to observe two separate images. “3-D” movies create the disparate images by splitting the image using lenses of two colors or two different polarizing planes. Our brain combines these images to create a stereoscopic, three dimensional reference. When referring to the human vision system, we call this fused, simultaneous binocular vision. The perception is that of an object-oriented spatially real image.

But sometimes objects aren't necessarily real. Let's look at “The Magic Eye”™, those 3-D composite images that you stare at, and then, as if magic, a picture with depth and space appears from a flat photograph! It's not magic, of course, it's just stereoscopic vision. Two views are able to be deciphered from the single picture because you have artificially created double vision. Normally, when you view an object at a fixed distance in front of you, both eyes turn in slightly (converge) so that they're aimed squarely on the object. The focusing system also adjusts for that distance. By holding the picture close and turning your eyes so that they are aimed at an imaginary place in front of you, you’ve de-focused and un-crossed (diverged) your eyes to create a double vision view of the
picture. Your brain combines the two images and decodes the not-so-random patterns into a 3-D view!

**One eye works well and the other doesn't. What then?**

Let's examine the situation where you only have use of one eye. Do you see 3-D? That question has been bantered about for years and we do have good answers. Like, yes and no. True stereoscopic 3-D vision is not possible without the ability to process two, combined images. But within the human vision system, another factor comes into play: depth perception.

**Depth perception** is the process by which you understand the relative distances of objects in space and how they relate to each other. With binocular, stereoscopic vision, the task is simple. There is very clear spatial presentation. But along with this true 3-D view of things, our brain has learned to process visual images by comparing the relative sizes, horizontal and vertical orientations, object overlap and shadows projected within the field to further define our perceptions of the world around us. These are monocular functions: only one eye is needed.

Back to the original question: If you have the use of only one eye, you’ve probably learned to understand spatial reality, but how you perceive it is different than those with full binocular vision.

**Here are some home and field experiments for you to try.**
**These will help you clearly define these differences in real-life terms**

1. View one of those 3-D photographs or holographic film. If you can see the stereo image, close on eye. The 3-D image is gone. If you do not have the ability to see nearly equally with both eyes, you can not perceive 3-D from these sources.

2 View a scene with great depth, for example an outdoor viewscape with trees or other large objects in the background and some smaller objects in the foreground. The far-point background should be a clear sky. Stare out into the distant sky and view the scene with one eye covered. At first, it may appear noticeably flat but soon you'll begin to see some “depth.” Now view the scene with both eyes. You will notice an immediate, significant expansion of depth of field, as is called. This is the true binocular stereo effect kicking in.

**What if you don't have binocular vision?**

Most people get along just fine without true binocular vision. Some do have some difficulty with certain tasks under certain situations. Driving a motor vehicle, especially if one eye is blurred or otherwise unused, can sometimes be troublesome. Threading a
needle is chore. Some sports need good binocular vision as does viewing holographs! A young child who is delayed in learning to walk or, later, bumps into things (more than normal) should be examined by an eye doctor, preferably an optometrist who understands and can test binocular function. Sometimes there's a fairly straightforward diagnosis and management plan. There are a number of vision system causes for loss of binocular function. It is possible, although much more rare, for “higher level neurological dysfunction” to be the culprit. These would be problems within the brain or the connections between the eyes and the visual processing center in the brain.

What are the causes and correction for loss of binocular vision

There are number of causes for the lose of binocular vision. The two primary issues are amblyopia and strabismus.

**Amblyopia (lazy eye)**

**Definition**: a condition of reduced visual acuity, usually unilateral and infrequently bilateral, which is not correctable by refractive means and is not attributable to any obvious structural anomalies or ocular disease.

There are a number of causes for amblyopia. These include: visual deprivation in early childhood (for example, a child born with a cataract or corneal scar), strabismus (see below), uncorrected refractive error, and neurological disorders within the eye or in the connections to the brain. Many of these causes result from early childhood deficits. Amblyopia can develop in an adult as a result of neurological trauma, nutritional deprivation or chemical insult. The primary chemical insults are nicotine (“tobacco amblyopia”), alcohol, and salicylate poisoning. There are also cases of hysterical or psychogenic vision defects.

The vision system needs to see equally and simultaneously from both eyes. If only one eye has an optical focus error, or the degree of error is significantly different, the eyes don't work together. The fix: eyeglasses or contact lenses. When clear vision develops in one eye but not the other, the condition called amblyopia occurs. In amblyopia, even when the brain receives a clearly focused image, it can not process that information. In certain circumstances, amblyopia can be helped. The treatment consists of hyper-stimulation of the weaker eye and de-stimulation of the stronger eye. This is accomplished by patching the good eye and/or through intense training of the weaker eye and the encouragement of neurological integration. The success of the treatment of amblyopia varies (see comments below) and is considered rarely functionally successful if it is a long standing deficit. But then some people do re-learn to walk after being paralyzed and recover from severe neurological impairments caused by strokes. In modern medicine and healing many things are possible.
**Strabismus** (cross eye, wall eye, squint)

**Definition:** *misalignment* of the eyes, failure of the eyes to look simultaneously at the same point in space.

Sometimes, the focus is correct but the eye muscles don't maintain ocular visual axis alignment. One eye is turned out or turned in. This is called *strabismus*. The causes include: early childhood disruption of vision in one eye, congenital defect in the length or function of one of the muscles that turn the eyes, neurological damage in the connections to the muscles or in the brain, or uncorrected large refractive errors, especially hyperopia. The last cause is called *accommodative esotropia* and is a common and easily correctable form of strabismus. The fix for the various causes of strabismus is relative to the cause. If there is a farsighted correction, spectacle or contact lenses are indicated. If the muscle is too long or short, surgery is sometimes indicated. Exercises to strengthen weak muscles and/or facilitate neurological integration, or prism lenses to adjust the angle of the incoming image are other remedies. Sometimes these remedies are combined in a treatment plan. Ophthalmologists are the practitioners who generally perform strabismus surgery. Optometrists who specialize in developmental vision care often treat the functional deficits. The functional success rates vary, and, as adults, some people seek a remedy solely for the cosmetic effect. A diagnosis and treatment plan may disclose outcome in a case by case situation, often with reasonably good certainty. As a basic statistical guideline, the earlier the problem is detected and mitigated, the better the prognosis for single, clear, simultaneous binocular vision. As a rule of thumb, children between age two and five are the best candidates for correction resulting in usable binocular vision. Good success has been seen in older children, too. Adults desiring a cosmetic improvement are likely to be very pleased with the surgery, although recovery of full binocular vision is a less likely outcome.