A LINE ON LIFE

3/21/84, Updated 6/21/01

Visual Depth Cues: Near or Far?

David A. Gershaw, Ph.D.

In another article, we covered some of the monocular cues that allow us to see depth while only using one eye. Now we will discuss **binocular depth cues** – those that require two eyes. How do they work? How are they better than monocular cues?

In contrast to a multitude of monocular cues, there are only two binocular cues – convergence and retinal disparity.

If you are looking at an object over 50 feet away, both eyes are parallel. However – as the object gets closer than 50 feet, you eyeballs will rotate to come together. This is **convergence**. This movement allows the image from the object to fall on corresponding parts of each eye, so you brain can perceive a single object rather than two. If there is something wrong with the external eye muscles, so they do not converge well, this is one cause of **double vision**. (This problem can often be corrected by surgery.)

The stretching and puling of the external eye muscles send impulses to the brain to give you this depth cue. Some might respond, "*I don't feel any pulling of my eye muscles!*" Even though you may not be consciously aware of it, the convergence is still registered by your brain. To become aware of convergence, hold your thumb at arm's length in front of you. While watching your thumb, slowly bring it toward your face, unitl you touch the tip of your nose. Do you feel the eye muscles stretching now?

More people are aware of the other binocular cue – **retinal disparity** – because of its use in "*3-D*" movies. We have two eyes, approximately 2.5 inches apart. Because of this separation, there is a difference (disparity) between the images that fall on the back (retina) of each eye. The closer the object is, the greater the disparity of the images is on the retinas.

For "3-D" movies, two cameras are used. Their lenses are 2.5 inches apart, just like your eyes. You need to wear 3-D glasses to see these movies. These glasses allow only one image to reach each eye, reproducing retinal disparity. You perceive depth with monocular cues in regular movies. However, with "*3-D*" movies, the image seems to leap off the screen at you!

When we look at a regular movie or photograph, we can still tell that the screen or photo is flat. The same thing happens when we watch television. We can perceive depth, but the TV screen still looks flat. (Otherwise, we might try to reach in and grab some of the tempting foods that are shown on TV.)

Even though monocular cues help,
binocular cues increase the effectiveness of our depth perception.

How can the TV image have depth and seem to be flat at the same time? Essentially, it is due to a **perceptual conflict** between monocular and binocular cues. The monocular cues give the image depth, but the binocular cues indicate flatness. To illustrate this, find a photo that seems to have a great deal of depth. This means that the monocular cues indicate depth. However, your convergence will be the same for both near and far objects in the photo. Likewise, the same amount of retinal disparity exists for all objects in the photo.

To demonstrate the contrast between the photo and depth in reality, close one eye to get rid of your binocular cues. Now extend one arm fully, so your thumb covers a distant object. Now place your other

thumb near the elbow of your extended arm, so your closer thumb covers both your other thumb and the distant object. Once you have done this, close the open eye and open the other one. Which thumb seems to move the most? Switch eyes repeatedly to experience the changes more fully. Because of the greater disparity, the closer thumb seems to move more. This should give you a greater appreciation of how your eyes combine images to give you retinal disparity.

To add more excitement to your TV viewing, eliminate you binocular cues, so only the monocular cues are used to experience depth. A good way to do this is to roll up a sheet of paper into a tube. Closing one eye, put the tube up to the other, so all you can see is the TV screen. The feeling of depth would be more apparent, if you are viewing a sequence that gives you the *rider's view* of going down a roller coaster, hang gliding or skiing down a slope. Since binocular cues are blocked out, your TV trip will seem more realistic. (However, I would not recommend this demonstration, if you have a weak stomach.)

So – even though you may still be able to get around adequately with only one eye, two eyes are better than one.