

Figures from
Fixing My Gaze: A Scientist's Journey into Seeing in Three
Dimensions
by Susan R. Barry

CHAPTER 1:

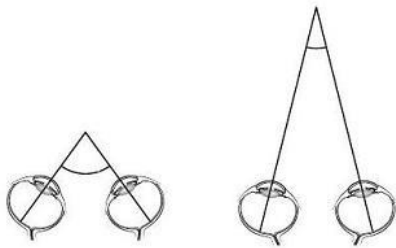


Figure 1.1: Your eyes turn in, or converge, to fixate, or look directly at, a near object; they turn out, or diverge, to fixate a more distant target. The straight lines in the figure indicate the lines of site for each eye. (© Margaret C. Nelson.)

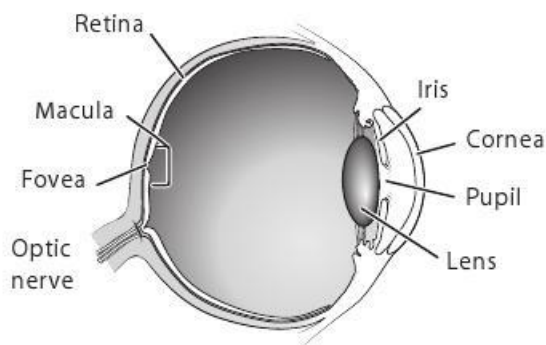


Figure 1.2: The human eye including the pupil, lens, and retina. The central region of the retina is called the macula, and the center of the macula is the fovea. The blind spot is located where the optic nerve leaves the retina for the rest of the brain. (© Margaret C. Nelson.)

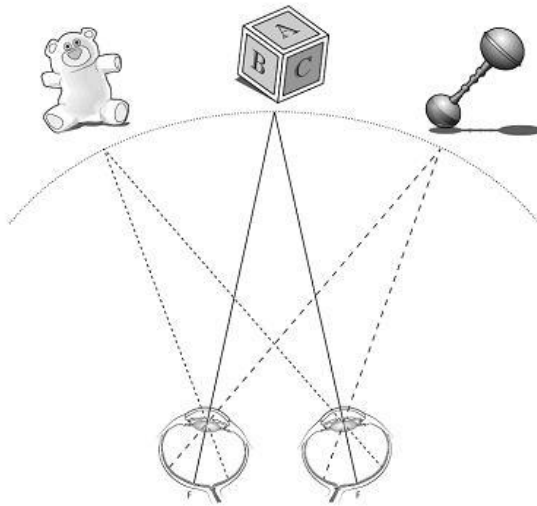


Figure 1.3 We can divide each retina into three regions: the fovea, or central region, the right side, and the left side. When you look directly at an object, its image falls on corresponding points on the foveal region (F) of both retinas. Other objects that cast their images on regions that are the same distance and in the same direction from each fovea also project to corresponding retinal points.

Imagine that you are looking directly at the toy block in figure 1.3. The teddy bear located to your left casts its image on corresponding points on the right side of both your retinas, while the rattle, to the right, casts its image on corresponding points on the left side of both retinas. (© Margaret C. Nelson.)

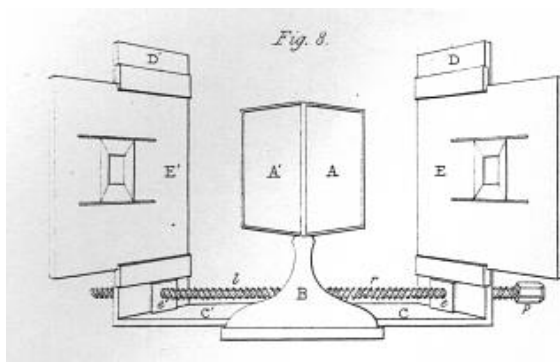


Figure 1.4: Wheatstone's illustration of his stereoscope. In this drawing of a stereoscope, the two A's in the center represent mirrors oriented at 90° to each other. To use the stereoscope, you place your nose right at the juncture between the two mirrors. In this way, the right eye can see only the reflected version of a photograph placed at E in the figure, while the left eye can see only the reflected version of the image at E on the other

side. Wheatstone placed into right slot *E* a mirror-image picture of an object as it would be seen by your right eye and into left slot *E* a mirror-image picture of the same object as it would be seen by your left eye. If you were to look into the stereoscope, your brain would fuse the two images into one, and you'd see the image in stereoscopic depth. (From: Wheatstone C. Contributions to the physiology of vision.—Part the first. On some remarkable, and hitherto unobserved, phenomena of binocular vision. *Philosophical Transactions of the Royal Society of London* 128 (1838): 371–94.)

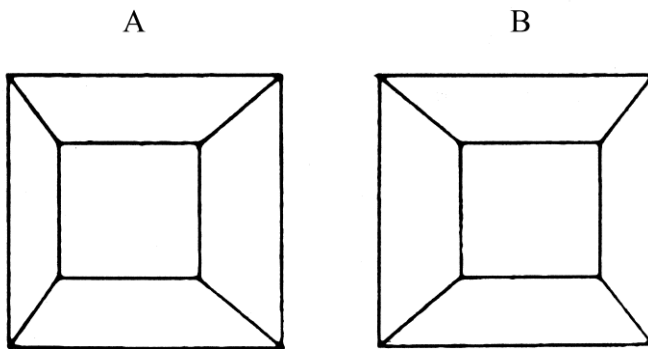


Figure 1.5: A stereo pair used by Wheatstone in his stereoscope. (From: Wheatstone C. Contributions to the physiology of vision.—Part the first. On some remarkable, and hitherto unobserved, phenomena of binocular vision. *Philosophical Transactions of the Royal Society of London* 128 (1838): 371–94.)

CHAPTER 2:



Figure 2.1: Early photos of me as an infant and toddler. In each photo, I am looking out of one eye while the other eye is turned in. (Barry family photos.)

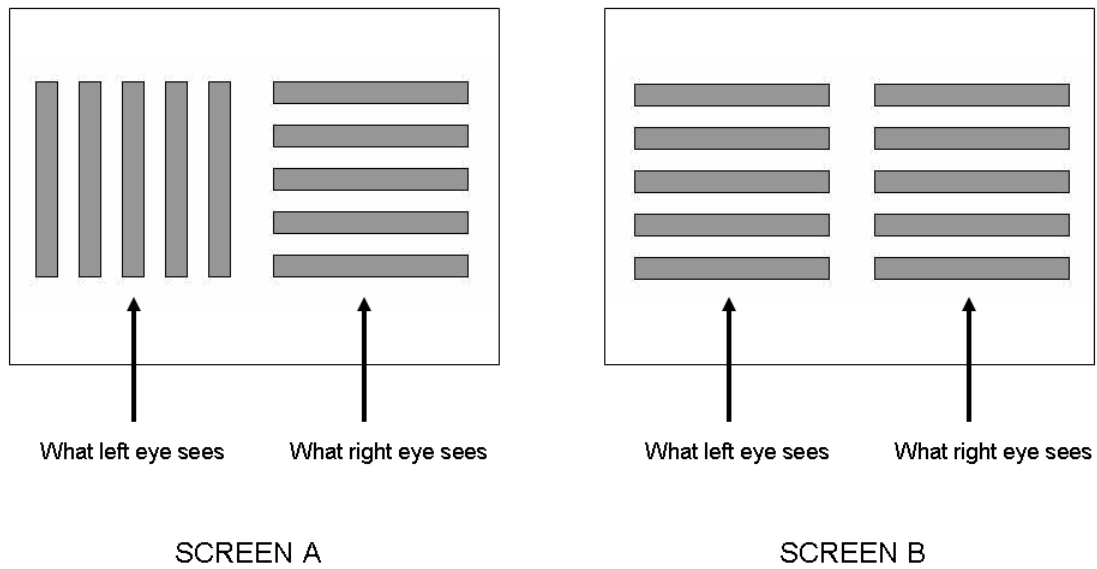


Figure 2.2: Set-up for the preferential-looking experiment. Infants were shown two different screens as depicted above. While wearing the goggles and looking at screen A, the infants saw vertical lines with one eye and horizontal lines with the other. When looking at screen B, the babies saw identical looking lines with each eye. If an adult were to look at screen A with vertical lines seen by one eye and horizontal lines seen by the other, the adult would experience binocular rivalry. (Adapted from Shimojo S, Bauer J Jr, O'Connell KM, Held R. Pre-stereoptic binocular vision in infants. *Vision Research* 26 (1986): 501–10.)

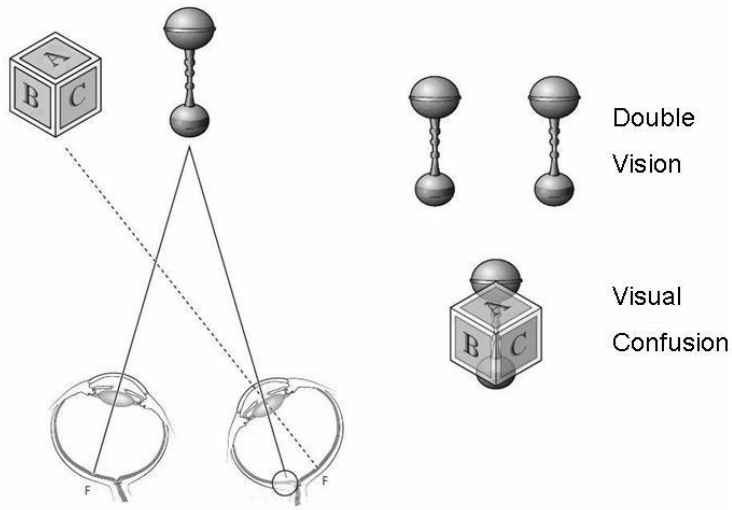


Figure 2.3: The left eye is aimed at, or fixating, the rattle while the right eye is turned inward and fixating the toy block. This situation can lead to double vision (the rattle is seen twice) and to visual confusion (the rattle and block appear to be located at the same point in space). (© Margaret C. Nelson.)

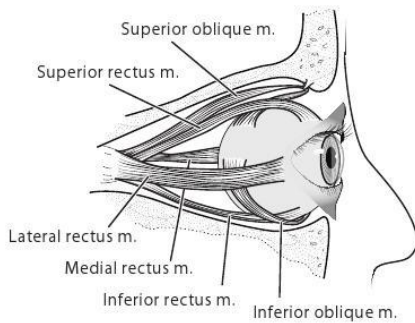


Figure 2.4: The six muscles that move the eyes. Dr. Fasanella operated on the medial and lateral rectus muscles of both eyes and the inferior rectus muscle of my right eye. (© Margaret C. Nelson.)

CHAPTER 4:

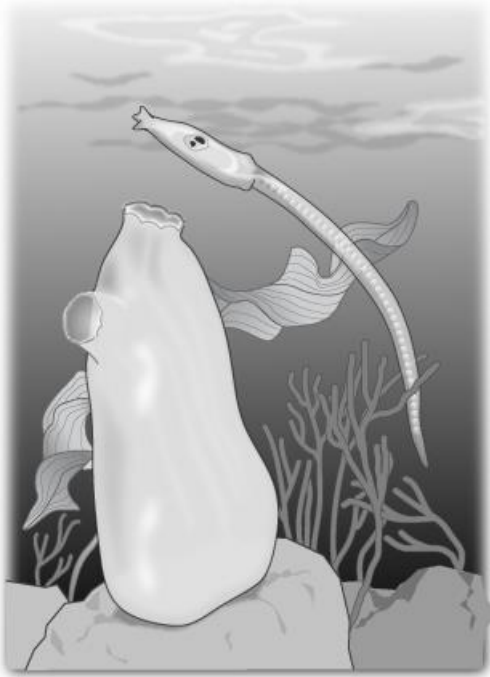


Figure 4.1: The tunicate as a sessile adult (left) and swimming larva (right). Tunicates, have eyes when they are young larvae in order to swim about and find a good place to settle down. Once they settle down and transform from active swimmers into stationary filter feeders, their eyes and brain degenerate. They have little need for a good visual system and brain if they are not moving. (© Margaret C. Nelson.)



Figure 4.2 When looking straight ahead, your sensed visual direction is not the direction in which either eye is pointing but one that seems to emanate from the center of your forehead. (© Margaret C. Nelson.)

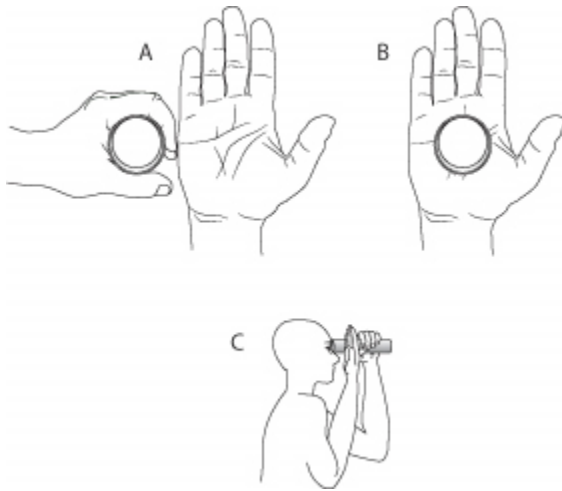


Figure 4.3: The “hole-in-the-hand” experiment. Parts A and C demonstrate the setup for the experiment, while part B shows what a viewer with normal vision will see. (© Margaret C. Nelson.)



Figure 4.4 A patient behind the phoropter. (© Rosalie Winard.)

CHAPTER 5:

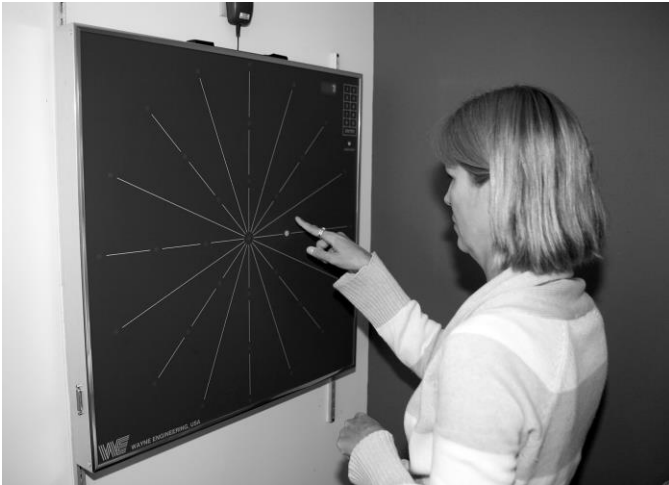


Figure 5.1: Heather Fitzpatrick playing the “wall game” with the Wayne Saccadic Fixator. (© Rosalie Winard.)

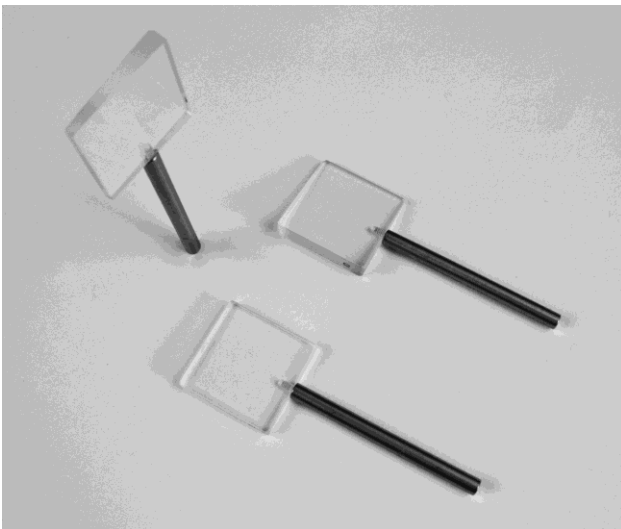


Figure 5.2: Loose prisms. I used these with the red/green panel exercise to learn to aim my two eyes at the same spatial location, thus reducing suppression. (Photo by James Gehrt.)



Figure 6.1: Me using the Brock string, a household piece of spring along which wooden beads are threaded. (© Rosalie Winard.)

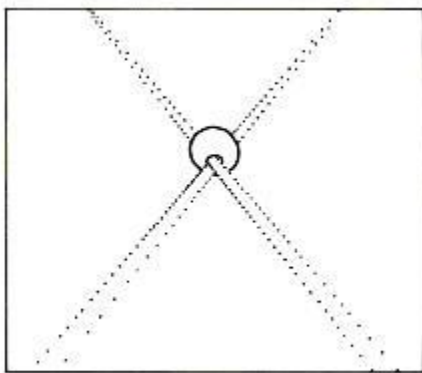


Figure 6.2: When a person with normal vision uses the Brock string as shown in Figure 6.1, the bead appears in the center of an X formed by four images of the string. (© Julia Wagner.)

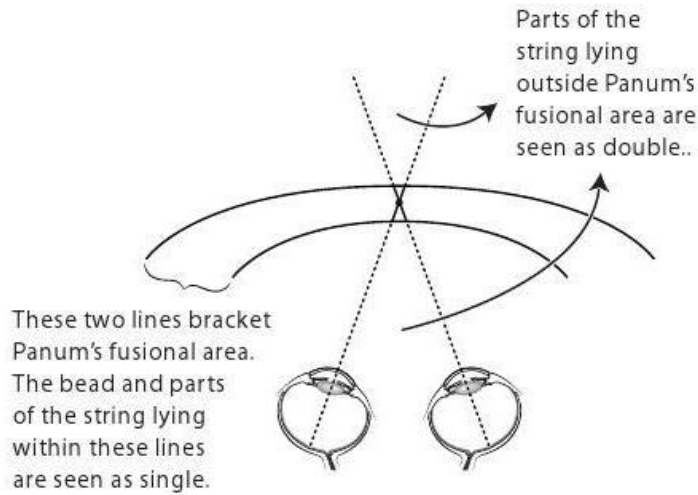


Figure 6.3: Panum's fusional area. Each dotted line represents the line of sight for each eye.

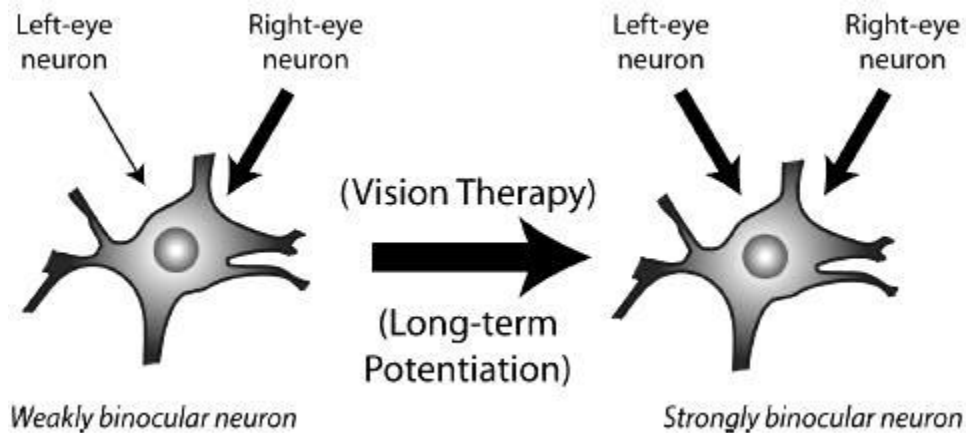


Figure 6.4: When I learned to aim both eyes at the same place at the same time, visual neurons in my brain received correlated input from both eyes. By a process called long-term potentiation, the connections between both eyes onto visual neurons may have been strengthened, converting weakly binocular neurons into strongly binocular ones. In this figure, the postsynaptic cell is the binocular neuron. The thickness of the arrows indicates the strength of the connections. (© Margaret C. Nelson.)

CHAPTER 7:

Figure 7.1: See <http://www.metmuseum.org/Collections/search-the-collections/150000154> for the painting of Princess Albert de Broglie, née Joséphine-Eléonore-Marie-Pauline de Galard de Brassac de Béarn by Jean Auguste Dominique Ingres. When I used to look at this painting before my vision therapy, I thought that the pleats and grooves in the princess' clothes were painted in an exaggerated manner. No one, I believed, really saw the texture of the gown in that kind of depth and detail.

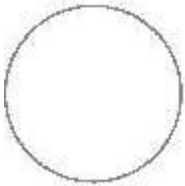


Figure 7.2: This drawing of a circle could represent a three dimensional ball or a flat disk.

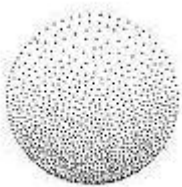


Figure 7.3: Shading evokes a sense of three dimensionality. (© Julia Wagner.)

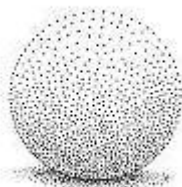


Figure 7.4: Adding a shadow further increases the sense of three dimensionality. (© Julia Wagner.)

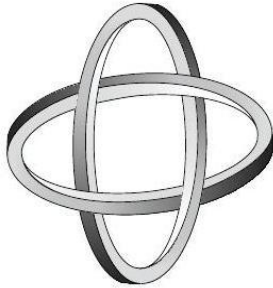


Figure 7.5: Which wheel is blocking which? The use of the depth cue, object occlusion, makes this drawing ambiguous. (© Margaret C. Nelson.)



Figure 7.6: In this painting by my father, the distant buildings are drawn to appear hazier, creating the sense that they are further away. This distance cue is called atmospheric perspective. (© Malcolm Feinstein.)



Figure 7.7: My father used linear perspective in this painting to suggest that the road extends into the distance. (© Malcolm Feinstein.)

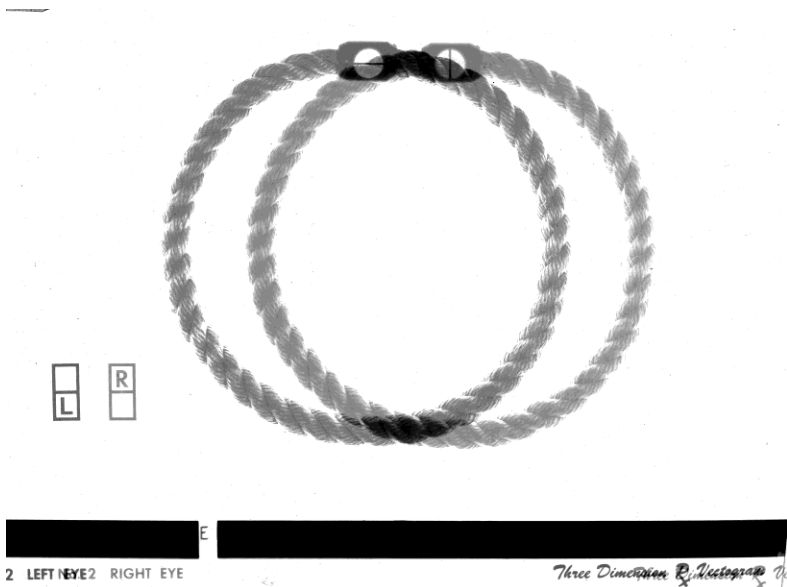


Figure 7.8: The quoits polarized vectogram, a vision therapy tool used to promote binocular fusion. The photo shows two overlapping sheets. Each sheet contains an image of a rope circle (also known as a quoit). When the viewer wears polarized glasses, each eye sees the image on only one of the sheets. To see just one image of the rope circle floating in depth, he or she must fuse the right- and left-eye views. (Photo by James Gehrt.)

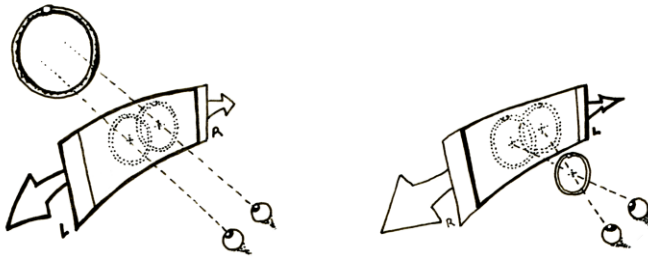


Figure 7.9: The SILO effect. As the fused image of the rope circle appears to recede in space, it looks larger. As it appears to float forward, it looks smaller. (© Julia Wagner.)

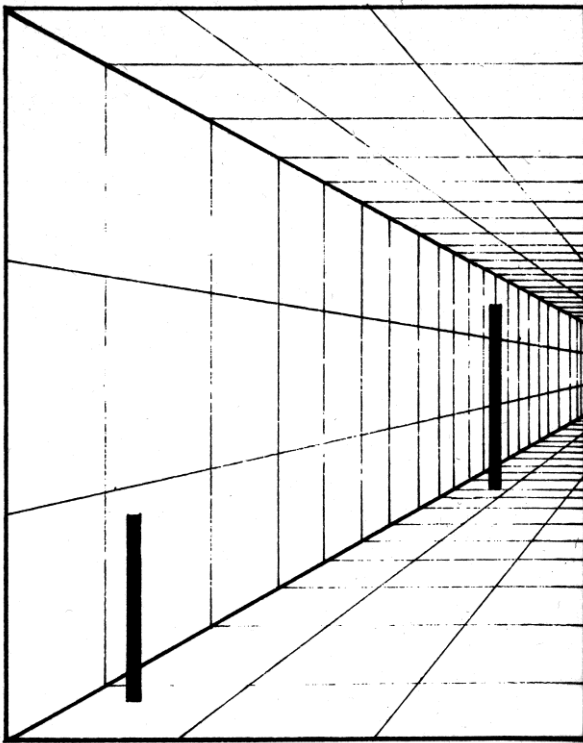


Figure 7.10: This “corridor illusion” also makes use of the phenomenon of size constancy. The two poles in figure 7.10 are actually the same height. However, we judge the pole on the right to be further away due to the decreasing size and converging lines of the floor, wall, and ceiling tiles. Since we interpret the right pole as further away, we see it as taller. (Deregowski J in Gregory RL, Gombrich EH (ed). 1973. *Art and Illusion*, London: Duckworth.)

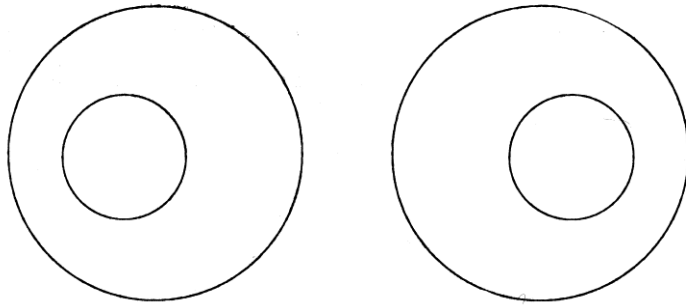


Figure 7.11: A nonrandom dot stereogram. If you are able to cross your eyes and “free-fuse” these two images, the inner circle will appear to pop out. If you fuse the images by looking “through” the page, the inner circle will appear to recede behind the paper.

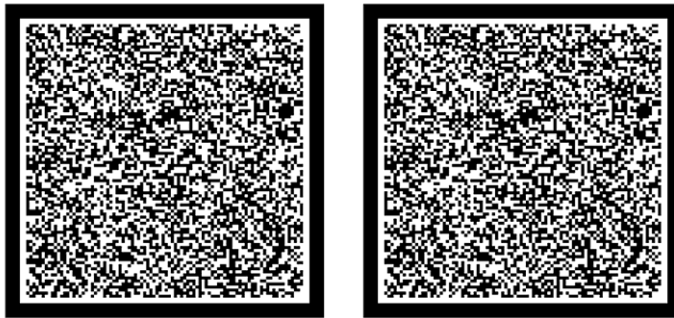


Figure 7.12: A random dot stereogram. If you cross your eyes to free-fuse the stereo pair, a central square will appear, as if by magic, to float in front of the background. (Free fusing a random dot stereogram is difficult to do even for people with normal vision.) (Stereogram by Benjamin Backus.)

CHAPTER 8:

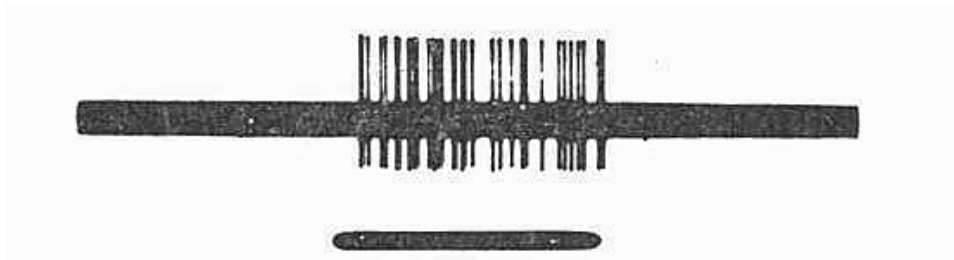


Figure 8.1: An example of a recording from a nerve cell taken from Hubel and Wiesel's first paper on the cat visual cortex. The lower bar indicates when the nerve cell was stimulated with a light pattern. During this time, the neuron fired impulses. (Hubel DH, Wiesel TN. 1959. Receptive fields of single neurons in the cat's striate cortex. *Journal of Physiology* 148: 574-91, Blackwell Publishing.)