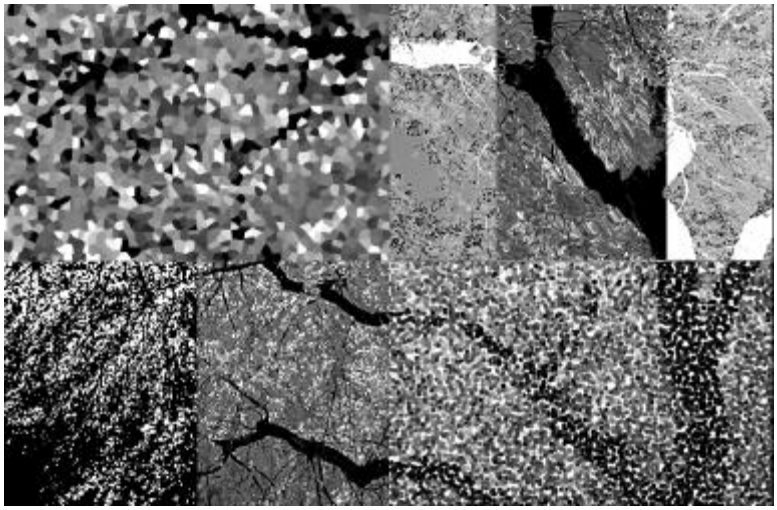
SECTION 1: PERCEPTION, THE EYE, TECHNOLOGY



All the mighty world of eye and ear, both what they half create, and what perceive.

William Wordsworth
Lines Composed a Few Miles Above Tintern Abbey [1798], l. 105

Introduction

Although eyes are part of our sensory equipment, perception is a process that occurs in the complex interactions between eye and brain. Perception is not static–it changes in the individual over time, and within society. People are born with sensory tools such as sight, taste, hearing, smell and touch. There are many others too, from the sense of balance to the ability to sense temperature. Perception, or the process of perception, is partly a learned skill.

Over the centuries, perceptions of reality have been transformed by technology. Tools such as the telescope, the Claude Glass, the daguerreotype, the camera, and the computer have opened new visual worlds, fostered a new range of perceptual skills, and encouraged the growth of new perceptual preferences in society. New technologies help to create new ways of perceiving the world around us, and shape the way we interact with our environment and each other.

Human perceptions change in relation to our visual and cultural environments. People once lived in small communities for their entire lives. The world around them was familiar, and remained relatively stable, for long periods of time. Today, people are bombarded daily with hundreds or thousands of changing visual images. Our complex, visual environments cannot help but influence the way we experience the world around us.

In this section, students will explore human perception from three different, but related perspectives: from the point of view of biology, optics, and technology. It begins with human vision, and the complex interrelationships that occur between the eye and brain. From observing and studying these relationships, people have formulated theories of perception. Those theories, and related concepts, are the keys to understanding how to interpret and create visual images. Our perceptual abilities change as our visual environment is changed by advances in technology.

Students should be encouraged to explore many of the ideas presented here through individual or group projects. Since human perception is learned, students should be aware that their own experiences of perception are highly relevant to this section of the course.

Hint: *At the beginning of this section, much of the information presented could be "team-taught", involving the biology and/or physics departments.*

1.1 PERCEPTION AND SENSATION

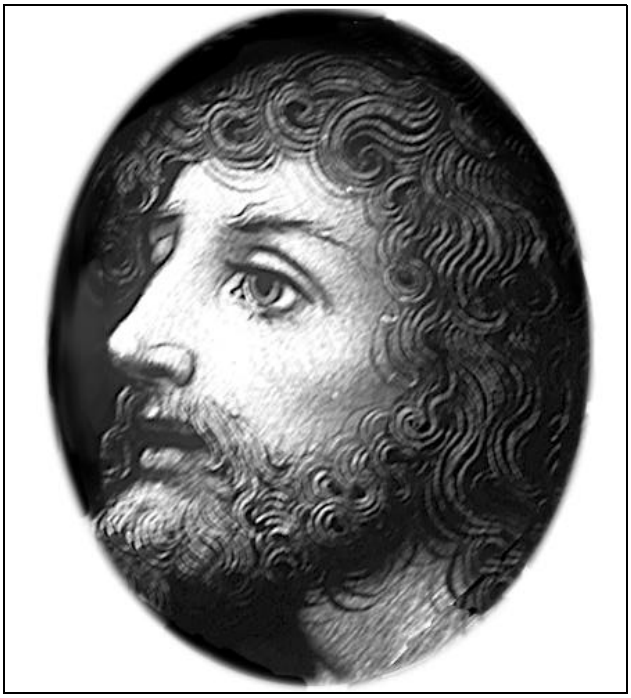


Figure 1.11 *The eye is often thought to be the primary sense in humans, but many other senses are involved in providing a complete picture of the world.*

Every man takes the limits of his own field of vision for the limits of the world.

Arthur Schopenhauer
Studies in Pessimism [1851]. Psychological Observations

Specific Curriculum Outcomes

Upon completing this section, students will be able to:

- explain and illustrate the differences between sensation and perception
- describe, through examples, the process by which humans sense, and then perceive objects in their environment
- describe and illustrate the relationship between works of art, style and perception
- create images which incorporate the concepts associated with perception and sensation
- demonstrate an ability to reorganize information, materials and ideas to arrive at new configurations
- apply research skills in acquiring information to build a knowledge base from which to make decisions
- evaluate the context of images they produce

- demonstrate an understanding of and sensitivity to cultural bias when creating images
- understand the role of cultural bias in the depiction of space
- show empathy towards other people's ways of seeing
- identify point of view in their own work and the work of others
- assess the impact an image might have on a given audience
- evaluate the context of images they produce
- anticipate the impact the use of particular tools might have on an image.

Introduction

As we begin to explore perception, it is important to understand what perception means, and how it is different from sensation. Human beings both sense and perceive. Knowing the difference helps us to make sense of our understanding of the world around us, and the incredible diversity of human, creative expression.

Sensation is the beginning of our ability to understand the environment. Before we can perceive, we must sense something. Our senses equip us to gather information from and about our environment.

Sensations are the result of the activities of our senses. The ones we are most familiar with: sight, hearing, taste and smell, are not the only senses we possess. Others include what are called somatic sensations - touch, heat, cold, and pain. The receptors for these sensations lie in the skin. We also sense hunger or thirst; those receptors are located within the body.

A sensation is a response to something. A stimulus activates a receptor. For example, the smell of a baking pie activates receptors in your nose. The smell of fresh-baked pie is the stimulus. But being aware of the smell of pie is not so simple. Several things are needed. One is the smell itself. Another is the sense organ–a nose–that can react to the smell. A third is the ability to transmit an impulse from the nose to the brain–what is called a nerve pathway. And finally, an area of the brain that can convert the message from the nose into a sensation. Without everything working together, you would not be aware of the smell of a fresh-baked pie.

Human senses can be quite different from those possessed by animals. Few creatures can see in colour, but many can see better in the dark than humans. Some animals possess acute senses of touch, smell, or hearing. In humans, the sense of sight is primary. It is estimated that we receive more than 85% of the information about the world around us, using vision.

How does sensation turn into perception?

Sensation and perception are closely related. A sensation occurs when one of your sense receptors, like the ones in your nose, are triggered by something...a smell. Once

you are aware of a sensation, your brain is involved. Your response to a smell might be something like this:

- What is that smell?
- How strong is it?
- Is it pleasant or unpleasant?
- Does it make me hungry?
- Should I do something as a result of this smell?
  (Is it dangerous? Should I tell someone, like my parents or the police?).

PERCEIVE

1. To become aware of, directly through any of the senses, esp. To see or hear.
2. To take notice of; observe.
3. To become aware of in one's mind; achieve understanding[4].

It is your brain that interprets the signals sent by the receptors in your nose. Perception is "...a process that takes place in the brain, not in the eye. Information from the eye, like the piece of a puzzle, is analyzed in the brain and fitted into meaningful forms.[5]"

But how does all of this happen? How does the brain know which impulses are which? No one is quite sure. An individual "...does not hear light, taste sound, or smell pressure. How the cerebral cortex converts virtually identical nerve impulses into specific and distinct sensations is still a mystery..."[6]. All we know is that perception occurs in the brain. We also know that perceptions can be learned. Many of the conclusions your brain comes to, in the course of a day, are things that you have learned over many years. You look out the window, and see that it is raining. Is it a good idea to put on a raincoat? How do you know? You learned many years ago that when going out in the rain, it makes sense to put on a raincoat. You were not born knowing about the relationship between rain and raincoats. In a similar way, many of your perceptions about your environment, people, and things were learned. As people mature, they learn the behaviour of their society, their culture, their community, their circle of friends, their families. Their perceptions are shaped in part by these relationships.

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4 The American Heritage Dictionary and Electronic Thesaurus, 1987. Houghton Mifflin Company.

5 Compton's Encyclopedia, Online Edition, Downloaded from America Online, April 15, 1994.

6 Compton's Encyclopedia, Online Edition, Downloaded from America Online, April 15, 1994.

Perception and the Visual Arts

In the visual arts, we might think of works of art as examples of an individual's or a society's perceptions. Throughout history, cultures and civilizations have come and gone. Their art works reflect their beliefs, their ideals, their fears, and their desires. From their images, we can learn about their perceptions of the world.

Western society has a long tradition of image-making, spanning many different places and cultures. In the study of art works, images are grouped according to the place and time they were produced, and by the technology used to produce them. A general term for these groupings is *style*. Styles of art show that people from similar places and times shared similar perceptions. The images they produced had much in common, so much so that a person experienced in the study of art history can accurately place an unfamiliar image within the context of a particular civilization or culture.

The study of works of art shows that, over time, people looked at the world in very different ways. Their perception of their environment was influenced by their beliefs, and by their society. The images produced by our society tell a lot about our beliefs and perceptions too.

Hint: *Students could study images from all time periods and cultures for this section. Other resources could include the slides of Newfoundland art for the Intermediate Art program, images located at various sites on the Internet, and images from the mass media.*

Discussion

1. What do contemporary images tell us about our society? How are our society's perceptions of the world shown in our visual images? Select images from a variety of sources, and bring them to class for a discussion. Sources could include art works in a variety of traditional and contemporary media, magazine and newspaper photographs, advertisements, movies, and music videos.

2. What can we tell about other cultures' perceptions from their visual images? Students should research art works and visual images from other cultures, and present their findings in class.

Projects

1. Think of as many examples of perception as you can. Think of unusual ones as well as common ones. Write your answers on a piece of paper, and then discuss them as a class.

2. What is your perception of a red stop sign? What do you see besides an octagonal red shape with some writing on it? What does it mean? How do you know? Is there any relationship between its colour and its meaning?

3. What do you see when you look at a family photograph? What if you look at a family photograph of complete strangers? Of cousins, aunts or uncles that you have not seen in many years or have never seen? How does your perception change in each instance? How much of what you see was learned?

4. Using any one of a variety of media, create an image on the theme of Perception.

5. Using a photographs and magazine advertisements, create a collage on the theme of our society's perception of the environment.

1.2 THE BIOLOGY OF THE EYE

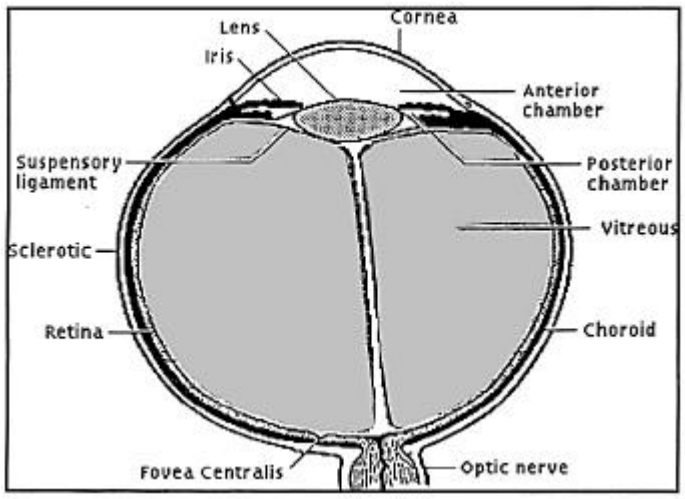

***Figure 3**: A cross-section of the eye.*[7]

Imagination is the eye of the soul.[8]

Joseph Joubert
French essayist, moralist

Specific Curriculum Outcomes

Upon completing this section, students will be able to:

- describe the structure of the human eye
- describe the process by which the eye functions
- describe some of the conditions associated with vision problems
- demonstrate an understanding of the relationship between human vision and technology designed to enhance the sense of sight
- create images associated with the physiological characteristics of vision.

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7 The American Heritage Dictionary and Electronic Thesaurus, 1987. Houghton Mifflin Company.

8 The Concise Columbia Encyclopedia, 1991. Columbia University Press.

Introduction

Understanding human visual perception begins with the eye. The working relationship between eye and brain is a key aspect of how and what you see. The eye has specific strengths and weaknesses. These aptitudes evolved over millions of years, to assist humans to survive. One of the special features of human vision is our ability to see colours. Few other creatures have the ability to do so.

The human eye is not large. In adults, it is approximately 2.5 centimetres (1 inch) in diameter. It sits in a special cavity in the skull, which protects it from injury, while providing a broad field of view. The basic components of the eye can be seen in tissues.

The human eye works in a manner similar to a camera (or perhaps it is more accurate to say that the camera was modelled after the human eye). It uses a single lens to focus an image. The lens on a camera is usually made of glass, and is a fixed shape. The lens in your eye is transparent like glass, but it is flexible—it can change its shape to help you focus on objects at different distances. The lens in a camera focuses light on special film made to be light sensitive. The lens in a human eye focuses light on a group of light-sensitive cells, called photoreceptors. They consist of two types: rods and cones, and exist in an area at the back of the eye called the retina. Cones are used for colour vision, while rods help you to see at night. Rods are only capable of transmitting information in black and white, which is why you cannot see colours when there is very little light.

The amount of light entering a camera is controlled by an opening in the lens that can be changed in size. In your eye, the opening is controlled by the pupil. Another mechanism used to control the amount of light entering a camera is the shutter. A light meter in the camera measures the amount of light needed to produce a picture, and then adjusts the shutter speed and the size of the opening in the lens. In your eye, your eyelid functions like a shutter, controlling the amount of light that enters the eye. The eyelid and pupil work together to ensure that enough light for proper vision is allowed to hit the retina.

Images are focused through the lens in your eye onto the photoreceptors in the retina. It creates an upside-down image composed of minute dots, much like the dots used to create a newspaper photograph (only much smaller!). Do you see an image made up of dots when you look at things? No, you see a continuous image. And you see it right side up, too! Why?

Once the photoreceptors in the retina of your eye react to light, they send a signal from your eye to your brain. There, the brain changes the image in a variety of ways, including turning it right side up. No-one is sure exactly what happens, but it is known that the image you “see” has been strongly modified by your brain. The modifications can take many forms, from adjustments of contrast, to subtle cultural and psychological interpretations.

Common Vision Problems

In most people the process of visual perception is similar but there are situations, as with colour blindness and night blindness, where the ability to perceive is influenced by other factors. Others may be caused by damage to the eye, such as looking directly at the sun. Although people with these conditions can see, what they see may be very different.

Colour blindness is a term we use to describe a condition in which a person has difficulty distinguishing between some colours. A common form of colour blindness is where people have difficulty distinguishing between the colours red and green. Colour blindness is hereditary—it is passed from parents to their children. Men are more likely to have colour blindness than women.

People who cannot see well in low levels of light are said to have night blindness. It is believed to be caused by a vitamin deficiency. People who see well close up but have difficulty seeing objects at a distance are nearsighted and those who have difficulty seeing objects near to them but see well at a distance are farsighted. Both of these conditions are caused by defects in the shape of the lens which cause difficulty in focusing. Other problems can include damage to the rods and cones caused by looking into the sun, a laser, or an eclipse of the sun.

The Technological Eye

Humans have created technological “eyes” to perform specific jobs. Satellites, like the Hubble telescope, relay pictures of our planet, and the vast distances of space, back to Earth. Remote controlled devices equipped with stereoscopic cameras such as the Pathfinder vehicle which landed on Mars, send us back 3-dimensional images making the experience of viewing them almost like being there. Underwater cameras transmit information on life many hundreds of feet below the surface. Special tools like night vision goggles allow people to see in very low light. Telescopes and microscopes assist in seeing objects far away, and objects too small to see. Special films make it possible to “see” images outside of the visible spectrum. Cameras and communications technology make it possible to see things happening many thousands of miles away. People have used technology to enhance vision, to make it possible to see much better, and in different ways, than eyes were designed to do.

Discussion

1. How many things can we see that our eyes were not designed to do? Research various kinds of vision extending and enhancing technologies, and discuss the results of the research in class.

2. How do human eyes function differently than other species'? Research vision in the insect and mammal worlds, and report back to class with your findings.

Projects

1. Find a partner. Hold a pencil or finger in front of your partner's eyes. Move it slowly back and forth to observe the tracking motion of the eyes, and how they work in parallel. Move the pencil or finger in and out to observe how the eye tracks objects at different distances from the eye. Notice how someone will appear cross-eyed when an object is close to the face.

2. Work with a partner. Using a weak light source such as a "pencil" flashlight, observe how the iris of your partner's eyes contract in the presence of increased light, and expand when the quantity of light is decreased.

3. Examine the lens of a camera. Compare how it is similar to, or different from the eye. Create an image that explores the differences.

4. Investigate how technology is being used to help people "see"; to simulate vision.

5. Virtual reality relies on "tricking" our eyes into believing we are seeing three dimensions (height, width, and depth), when only two dimensions (height and width) are present. Find out how this works.

6. Using a camera, take pictures of a number of familiar scenes. Compare them to your view of those scenes with your eyes. How are they different? Are the differences obvious or subtle?

7. Using any media, create two images on the theme "What My Eyes Can See". Use one image to express the properties of human vision, and another to describe the characteristics of insect vision.

Hint: *Conduct a search of the Internet to locate resources about the Eye, colour theory, and perception.*

1.3 THE VISUAL FIELD

Figure 1.31 *A stylized impression of the visual field*

`Tis distance lends enchantment to the view,
And robes the mountain in its azure hue.

Thomas Campbell
Pleasures of Hope [1799], pt. I, l.7

Specific Curriculum Outcomes

Upon completing this section, students will be able to:

- explain and illustrate binocular vision, the visual field and the cone of vision
- describe and demonstrate the processes by which the eye perceives depth in the visual field
- describe the process by which the eye scans images
- demonstrate an understanding of some of the psychological and cultural factors affecting scanning
- create images which utilize knowledge of how the visual field functions.

Introduction

When people look at the world, they see two similar, but slightly different views. That is because human vision usually involves both eyes, working together with the brain. This is called *binocular vision*. If you close one eye and then the other, you will see that your left eye gives you more information about things to the left and in front of you, and your right eye gives you information about things to the right and in front of you. The total area that you can see—from the far left to the far right, and from top to bottom—is called the visual field. It is extensive. If you want to test its outer limits, try looking straight ahead, and holding your left arm out straight in front of you, gradually move it to your left in a horizontal arc. You should find it difficult to see your fingers somewhere at right angles to the side of your face. If you think you cannot see your fingers or hand any more, try wriggling your fingers. Human eyes are sensitive to movement.

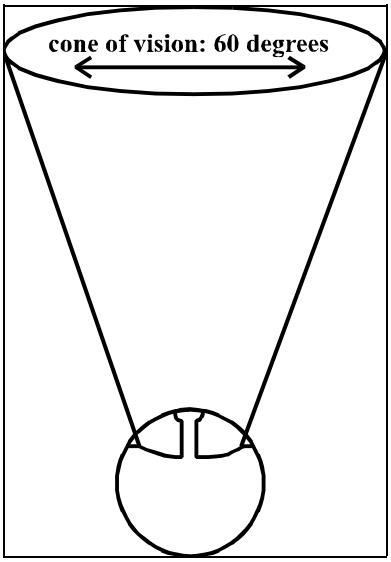

Figure 1.32 *Cone of Vision*

There is a space in front of you where the vision from your two eyes overlaps. That is where your vision is most accurate, and your ability to perceive depth is greatest. It is called the cone of vision. Your ability to distinguish shapes, detail, colours, texture, and depth are sharpest there. Because this area of your vision is so important, most often you keep whatever interests you within it. You move your head and eyes to make sure that whatever you want to look at stays inside the cone of vision. The muscles surrounding your eyes work together, so that when you have to move your eyes to focus on something, they move at the same time.

The image you see in the visual field is not all in focus. It is only the relatively narrow cone of vision where sharp, clear images are maintained. In order to gain an accurate picture of an image in front of you, your eyes must be continually moving, building a picture piece by piece. Your brain works to assemble this information into a stable view of the world.

People from Western society tend to look at bland visual information the same way they read books: they scan from left to right, and from top to bottom. There is a bias towards images, and large images are preferred over small ones. This pattern may not be the same for people from other cultures or backgrounds.

Interest plays a large part in how a person scans images. Someone with an interest in cars will pay more attention to them than someone who cares little. A person interested in dance will pay attention to a performance of Swan Lake, while someone who finds it uninteresting will not. When we are motivated, we see more. It is also true that when we have seen something

repeatedly, or for a long time, we lose interest. This means that visual interest declines over time, and with familiarity.

Scanning done by people works differently than the scanning done by machines. Scanning by humans is highly dependent on subjective factors like culture, or interest in the subject. Scanning by machines is an objective process that is always the same, regardless of subject matter.

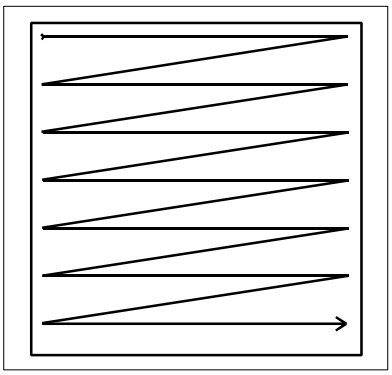

Figure 1.32 *The general pattern of scanning a page of information in Western cultures*

Depth Perception

In order to move around in, and interact with the world, it is important to be able to perceive depth. Depth perception relies heavily on a variety of senses besides vision, including hearing, and touch. When you move through space, all of your senses are working together to provide you with information about the world. Your perception of space and depth does not rely on sight alone, although your visual sense, is by far, the most dominant. Your ability to perceive space is formed by a complex interaction of senses. Your sense of scale in any space is partly derived from your sense of hearing. Your perception of the solidity of objects is, in large part, due to your sense of touch.

People have several ways of perceiving depth. Several exist because we possess two eyes that provide slightly differing views of objects. Others compare views of two different objects.

One of the tools used, is called accommodation. Your eye can see only one thing, or a small group of things, in focus at any one time. When you look at something close to you, distant objects appear blurred. When you focus on something distant out a window, the window frame appears blurred.

Another depth tool is disparity. This means that each of your eyes produces a slightly different view of the world. Make a circle with your thumb and forefinger, and look at an object with both eyes so that it is within the circle. Now close one eye, and then the other. Did the object seem to move? Did it move more when you closed one eye than another? Did you know that you favour your left or right eye, just as you can be right or left handed? That experiment is possible because of disparity.

The third tool used by binocular vision is convergence, which involves the relative angle of the eyes to each other when focusing on an object. Try holding a pencil at a distance from someone's face. Notice that their eyes are almost parallel while focused on the pencil. Now move it toward their face and carefully watch their eyes. As the pencil moves nearer, their eyes will converge, or move closer together, in order to stay focused. This eye movement provides cues to the brain for depth perception. Although not noticeable most of the time, it is a subtle depth cue of great importance.

Motion parallax is a depth cue that you have encountered many times. When you move your head and eyes, those objects nearer to you will seem to move further and faster than objects further away from you. You experienced this when traveling in an automobile. When you look out the side window, the scenery nearest you seems to rush past. The scenery in the distance however, seems to move much more slowly[9]. Motion parallax creates problems for perceiving depth in two dimensional images. Although many depth cues are present, the effect of motion parallax is not. If you move your head back and forth, different parts of the picture do not move at different rates. This helps to defeat the optical illusion of depth in the image.

Although the traditional still image of a painting or a photograph contains some, but not all depth cues present in the visual field, movies and videos include the effect of motion parallax. Some film technologies, such as the large-screen IMAX systems, have screens high and wide enough to encompass a very large part of the visual field. Even in this case though, a simple movement of the head to the left or right will reveal the image to be an illusion. New technologies, such as virtual reality, will take the optical illusion of spatial depth within the visual field to new levels of accuracy. Head movements will result in changing views of the environment, just as in reality. What will then happen to our definition of reality, and our perception of what is real?

Discussion

1. What is real? If the visual field can be accurately duplicated with the advent of new technologies like virtual reality, how can anyone tell fact from fiction? Students could research new technologies and how they affect our conventional ideas of reality and discuss the results.

2. How does the human visual field differ from those of other creatures? Students can select an animal or insect to study, and report to class on the results.

3. How do people react to the rapid image changes of music videos, and some contemporary television programs? Is it easy to follow what is happening, or does information move too rapidly?

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[9] Tom Porter and Sue Goodman, Designer Primer, (New York: Charles Scribner's Sons, 1988), p. 6-7.

Projects

1. Using any one of a variety of media, create an image of the visual field. Include all of the information that a person could see within his or her visual field.

2. Have one student stand in the middle of the room. Have two other students stand at either side, a few feet away. Have those two students move until the student in the middle can just see them at the edge of her peripheral vision. Mark their position on the floor with chalk. Then have the two students move by, waving their arms. Can they move even further back and still be seen by the student in the middle? Their new position should be marked with chalk too. An arc, representing the total field of view, can then be drawn on the floor.

3. Using a camera, take a number of pictures of a scene in the community. Take the pictures so that parts of them overlap. When developed, assemble the pictures together to represent all of the scene that would be in a person's visual field. A panoramic camera will reduce the number of images necessary to do this.

4. Using any one of a variety of media, create an image that reflects the way people scan the visual field.

5. Try to identify as many different technologies of scanning as possible. How does the scanning of the human eye compare with that done by scanners for digitizing visual imagery? How do they differ from the human eye? Do they scan for the same kinds of information?

6. Try to discover how many ways you can describe an environment. Can you describe it through touch, hearing, smell, sight, taste. Are there any other ways to describe it?

7. Try to discover how many parts of your body help you to know that you are in a moving car.

8. How do technological inventions describe space? Do they provide different kinds of information? Consider various forms of technology such as a camera, a microscope, a tape recorder, a smoke detector, radar, and an x-ray machine. Can you think of other technological devices that describe space to us? How many of them capture or express movement?