Vision

Madison Davis Mackenzie Dawkins
Ellen Smith Brianna Green Kaliyah
Shields

Introduction to Vision

- Vison is the act of seeing and sight. In cognitive science, vision and its interpretation is a data intensive process. It is also defined as an information-processing system that converts light into meaningful representations.
- Vision is important for perception because it allows you to create a mental image of the world. It is the primary dominant sensory modality for interpreting the environment and guiding actions. Vision is important for behavior because it helps to direct actions through visual-motor integration, processing information rapidly, and actions.
- The visual system transforms light into electrical signals via the eye's retina (rods and cones) sending them through the optic nerve to the brain's visual cortex for processing.

Anatomy of the Eye

- The cornea is the clear outer covering, where the contact lense is, the pupil is the whole made by the iris, the iris provides color, but its major function is to admit more (dialated) or less (consticted) light, and the lens focuses light on the fovea
- The retina structure organizes light signals from the outer photoreceptor layer through intermediate neurons to the innermost ganglion cells, forming the optic nerve to the brain
- The role of photoreceptors is to detect light and convert it into electrical signal

Photoreceptors: Rods vs Cones

- Rods are the cells that are responsible for night vision, they have a lower threshold (they work in low light)
- Cones are cells responsible for daylight and color vision, they have a higher threshold (e.g., they only work in bright light)
- Photoreceptors are unevenly distributed across the human retina. Cones are distributed at a low density throughout the retina with a sharp peak in the center of the fovea. Rods have a higher density throughout most of the retina, with a sharp decline in the fovea.

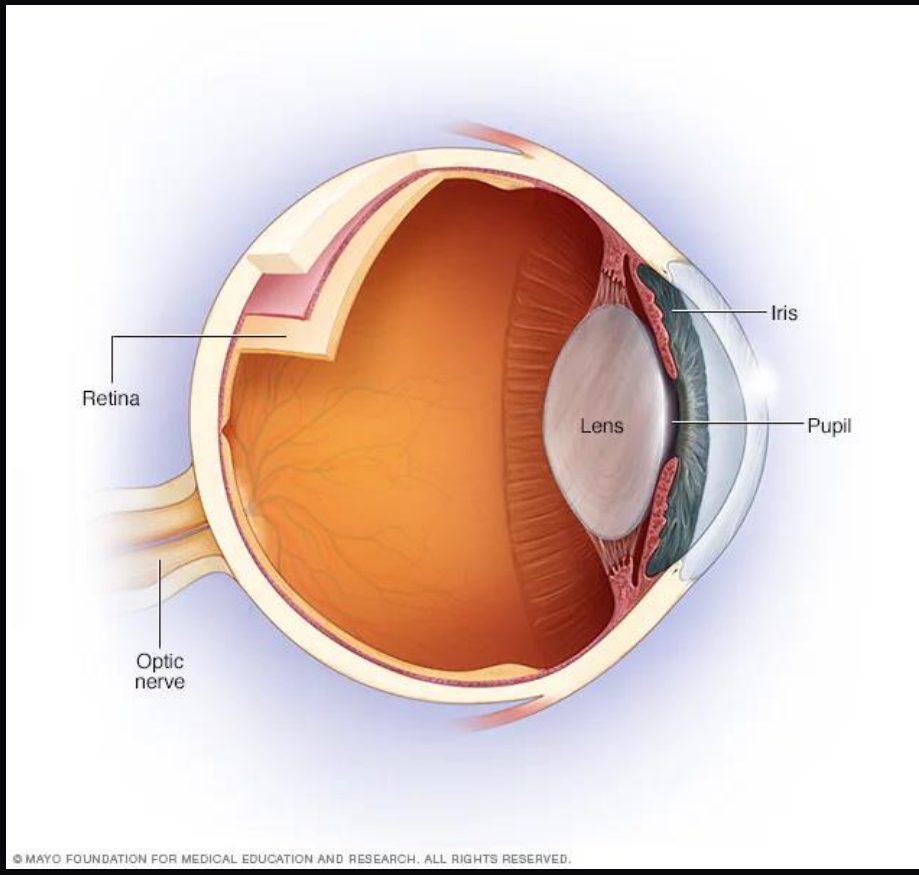
The Retina and Neural Processing

- Bipolar cells are specialized neurons in the retina, acting as the crucial middle link between photoreceptors and ganglion cells.
- Ganglion cells are the final output neurons of the vertebrate retina. The ganglion cell collects electrical messages concerning visual signal. They deliver this information to different site within the visual system.
- Signals leave the eye via the optic nerve by collecting electrical impulses from the retinal ganglion cell axons, which converge at the optic disc (blind spot) at the back of the eye

What is the Visual Pathway to the brain?

The visual pathway transmits light information from the retina to the brain's optical nerve. There are several important components but the four major ones are the Optic Nerve, the Optic Chiasm, Lateral geniculate nucleus and the Primary visual cortex.

- **The optic nerve is a pair of nerve bundles of over a million nerve fibers that acts as the primary communication link between the eye and the brain.**
- **The optic chiasm is an X-shaped structure at the base of the brain where partial crossing of optic nerve fibers occurs. It allows visual information from the right field to reach the left hemisphere.**
- **The Lateral Geniculate Nucleus (LGN) is a key sensory relay station in the thalamus(egg shaped structure in the center of your brain), responsible for processing visual information from the retina and transmitting it to the primary visual cortex.**
- **The primary visual cortex is located in the occipital lobe of the brain and serves as the initial cortical processing stage for visual information**



Visual Cortex and Depth Perception.

- The visual cortex is a specialized region in the occipital lobe at the back of the brain responsible for processing, interpreting, and organizing visual information received from the retina. The information is processed primarily through the occipital lobe. Located at the back of the brain, it decodes signals from the retinas, including color, motion, distance, and depth perception. It is responsible for the recognition of objects and faces, the mapping of the visual world, and sends information to other regions of the brain for memory as well as action.
- Depth perception is the ability to perceive the world in three dimensions (3D) and judge the distance of objects, allowing us to see length, width, and depth. It is made up of Binocular cues and Monocular cues.
- Binocular cues are depth perception signals that require both eyes, mostly retinal disparity(the slight difference in the images projected onto the left and right) and convergence. This allows the brain to perceive 3D space, measure distance, and manage near focusing. These cues work by combining the different images from each eye and sensing eye muscle tension, crucial for close up tasks.
- Monocular cues are visual, environmental, or movement based information that allow one eye to perceive depth, distance, and size. This includes relative size, interposition (seeing something as closer than it is because of another object), and linear perspective. These cues provide contextual, 2D information that the brain interprets as 3D depth.
- One thing depth perception is important for is navigation. It causes the brain to judge distances, perceive 3D space, and understand spatial relationships between objects. It allows safe movement by helping you to identify how far away obstacles are, manage speed while driving, and navigate uneven terrain like stairs or curbs, preventing accidents and collisions.

Color Vision

1.) Color vision : is the ability of our eyes and brain to see and interpret different colors of light

2.)Trichromatic theory: our eyes have three types of cone cells that detect red, green, blue light.

3.) Opponent-process theory: some colors work in opposite pairs (red/green, blue/yellow, black/white) which helps explain things like afterimages

4.) How the brain Interprets color: the brain compares signals from the cones and opponent color pairs to figure out the color we actually see

Visual Attention

1.) Visual attention: is how our brain focuses on certain things in our environment while ignoring other information. (e.g. reading; shifting focus from word to word ignoring the whole page)

2.) selective attention: focusing on one thing at time.(e.g. listening to a friend in a noisy room)

3.) bottom-up processing: attention is captured automatically by noticeable stimuli.(e.g. bright colors, or sudden movement)

4.)Top –down processing: attention is guided by our goals or expectations.(e.g. like searching for a friend in a crowd)

Visual Illusions

- White or gold and blue or black, this is an example of an illusion that happened a few years ago that went viral. The major debate was what color the dress was. There are also optical illusions and examples of these are when we look at pictures and things move, common colors for these types are black and white.
- When we fall for an illusion, this means our brains is misinterpreting information we are seeing and this creates a clashing between the picture and our brain.
- **Perception**- is when we are aware of things, we become aware by seeing and hearing.
- **Reality**- is when things actually exist as they are in their own nature.

Visual Disorders

- **Color Blindness**- this is the condition of not being able to separate or differentiate the difference between colors. Examples are *red- green, blue-yellow, and full color blindness*. About 8 percent of the world are in some way color blind.
- **Prosopagnosia-** the word means face blindness, to simply put it if you have this condition it's hard to recognize familiar faces examples would be family and friends. A little over 3 percent have this.
- **Visual agnosia**- this is the same eye condition as prosopagnosia but it is the condition of not being able to recognize familiar objects. There is not an exact percentage number for the people who have this condition.

Vision in Cognitive Science Applications

- Computer Vision: is a branch of artificial intelligence (AI) that enables machines to recognize, process, and understand visual information like images and videos. It uses machine learning techniques to extract useful insights and meaningful patterns from visual data.
- Artificial Intelligence (AI): is a major area of computer science that focuses on enabling machines to show intelligent behavior in response to external data. The aim of AI is to develop systems capable of performing tasks that normally require human intelligence. Ai is present in everyday life through virtual assistants, predictive search tools, and ride sharing apps.
- Human-Computer Interaction (HCI): is the study of how people interact with computers to accomplish specific goals. Its main aim is to design interactive systems that are effective and user-friendly. HCI goes beyond technology, incorporating insights from cognitive psychology and other disicplines. As a result, it is a multidisciplinary field drawing from computer science, psychology, design, ergonomics and more.

Animal Vision

Different animal eyes

Night Vision: Cats can see in light levels 6 times lower than what humans need.

Peripheral Vision: Cats have a wide field of view about of 200 degrees. while humans have around 180 degrees.

Color Perception: Cats are not completely color blind but they see fewer colors than humans.

Night Vision: Dogs have better low-light vision due to a reflective layers behind the retina. However, their night vision is not as strong as a cats.

Peripheral Vision: Dogs have a wide field of view of about 240 degrees.

Color Perception: Dogs are also not completely color blind but see a limited range of colors. They perceive the world in shades of blue, yellow and gray.

Other Animal Eyes






Visual Systems

- Eye structure variations: Different species have adaptations like vertical slit pupils, round pupils, or compound eyes to suit their needs.
- Night Vision: many animals such as cats, dogs, and owls have a tapetum lucidum for enhanced low-light vision.
- Motion detection: animals are often highly sensitive to movement, aiding hunting or predator avoidance.
- Field of view: Prey animals often have wider peripheral vision; predator animals have better binocular vision.

Binocular and Monocular Vision

BINOCULAR

- Binocular vision happens when both of an animals' eyes focus on the same object.
- It helps animals judge the depth and distance accurately.
- Predator animals such as cats, owls, and eagles usually have stronger binocular vision.
- Animals that have binocular vision are better at hunting and catching their prey.
- It also improves hand-eye or paw-eye coordination for precise movements.

MONOCULAR

- Monocular vision is when each eye sees various parts of the environment separately.
- It gives animals a wider field of view.
- Prey animals such as rabbits, deer, and horses habe monocular vision.
- This helps animals detect predators from the sides.
- Their depth perception is weaker than in binocular vision.
- This is great for when a prey animal is scanning larger areas for danger.

Conclusion

- Vision allows us to perceive color, depth, motion, and spatial relationships.
- Understanding vision shows us how the brain processes complex sensory information
- Studying visual perception helps reveal how attention, memory, and decision making interact with what we see.