An_Hand_Ep011_200114

Vision and Behavior

Our topics for this week are:

- Field of vision
- Pupil shape
- Depth perception
- Acuity
- Color differentiation
- Night vision

Glossary:

Acuity - sharpness of vision
Arboreal - tree-dwelling
Binocular - vision with combined input of two eyes
Cones - cells in the retina that perceive best acuity and perception of colors
Diurnal - active during daylight
Monocular - vision with one eye
Nocturnal - active at night
Rods - cells in the retina that perceive motion and images in dim light
Terrestrial - ground-dwelling

VISION

Vision is the primary sense used for detecting danger for many species. Impaired vision can affect an animal's tractability. For example, diurnal birds are more easily handled in subdued lighting. Blindfolds can be effective means to improve the ability to handle horses, lizards, and ratites (ostriches), in some instances.

The sense of vision is adapted for a species needs, particularly the needs of defense and communications. Visual ability encompasses field of view, depth perception, acuity (focus), perception of motion, and color differentiation.

Field of View

The field of view for predators is narrower than in prey animals. Dogs have a horizontal field of view of approximately 240 degrees, slightly wider than in humans. Cats have a horizontal field of view similar to dogs but a wider vertical field of view due to their vertical pupils.

The eyes of grazing/prey animals (horses, cattle, sheep, goats, rabbits) are located on the side of their head and protrude slightly in comparison to predator eyes. The side location and protrusion of their eyes allow grazing prey animals even greater horizontal peripheral vision. The horizontal vision of grazing animals is approximately 200 degrees or more with their heads

raised and up to about 340 degrees, with their head lowered in grazing position. The distance and peripheral vision of swine, a prey and predator, is poor.

Prey animals have both monocular and binocular vision. Prey animal eyes work independently of each other (monocular vision), except when looking ahead with binocular vision in the attempt to perceive depth. The binocular range of horses is 60 to 70 degrees straight in front. Only monocular vision is used for monitoring threats when grazing.

Pupil Shape and Light Accommodation

The pupil of prey animals adapted to living on open grassland is often horizontally oval, which further enhances peripheral vision. However, the vertical vision (being able to see above or below) is less in grazing prey animals than in humans or predators. Prey animals range of vertical vision is only about 60 degrees. To properly place their feet on unfamiliar ground or to step into unfamiliar water, they have to lower their head. Horizontal pupils enable prey animals to see vertical lines better than horizontal lines, while cats having vertical pupils can see horizontal lines better. Containment fencing with more vertical lines is a more effective psychological barrier for grazing animals than the more common fences that have long sections of horizontal planks or rails.

Snakes, like cats, are low profile hunters. Both have vertical pupils which may permit an enhanced ability to focus through thin vertical gaps in tall grass where they frequently hunt. Taller predators, such as dogs, lions, and tigers, have circular pupils.

Dilation and constriction of the pupil are the primary means of accommodating to changes in lighting. Livestock, diurnal species, have pupils that accommodate slowly compared to humans. Bird pupils and pupils in nocturnal animals, such as cats, accommodate relatively rapidly.

Depth Perception

Depth perception requires overlapping fields of vision from each eye. The central overlap that permits depth perception in dogs and cats that is about one-half that of humans. Dogs and cats also have limited peripheral vision. Humans and predator animals have binocular vision. They always focus on objects with both eyes. Livestock have monocular vision and can focus on objects on both sides of their body at the same time. When looking forward, animals with monocular vision can view the same object with both eyes (binocular vision) which is needed for depth perception. Horses have an overlap of 65 degrees but 350 degrees of panoramic vision. Extreme panoramic vision has poor acuity but detects motion easily.

Horses and most other grazing prey animals have good distance vision, especially for moving objects, but their ability for depth vision and ability to focus on near objects is slow and poor, requiring them to face the object of interest. In prey animals, shadows appear as holes, and water depth cannot be determined. Because of this, it is important to keep surfaces for them to walk on dry and lit by diffuse, shadow-eliminating lighting. Loading ramps that slant upward are easier for grazing prey animals to negotiate than steps. Consistent color, shading, and texture to prey animal handling floors are important to keep them from balking. A change in the color, shading, or texture of the surface of flooring will cause the animals to stop to reassess if there is a change in the depth.

Grazing animals need to see potential predators while grazing. Because of this, their retinas have the best distance perception with light entering through the top of their eye. To facilitate good focus on where they step and the condition of areas to graze, light entering the lower portion of their eye gives the best near-vision perception.

Grazing animals have a cone shaped blind spot four feet directly in front of their face. They also cannot see directly below their jaw. Objects that suddenly appear from a blind spot may startle them, particularly horses.

Acuity and Perception of Motion

Visual acuity is the ability to see details. Domestic mammals do not have the visual acuity of humans. Near vision is relatively poor. Normal humans have 20/20 acuity. Dogs are estimated to be 20/75 (normal humans can see clearly at 75 feet with the clarity that dogs see at 20 feet). Cats have 20/100 acuity, and horses have 20/33. Birds have exceedingly good visual acuity. Their lens is flexible which aids their ability to rapidly focus on objects. Visual acuity of reptiles is poor. However, reptile vision can vary with families depending on the species lifestyle. For example, arboreal snakes have better vision than terrestrial snakes that burrow.

In most predators the area of greatest acuity is a circular area in the retina, called the fovea or area centralis. To visually evaluate the greatest detail, predators have to hold their head still and concentrate the image on the fovea. In contrast, grazing prey animals have a visual streak, an elongated band that runs across the retina. This permits grazing animals to better detect motion in their peripheral vision.

Color Differentiation

Most animals see better in low light than humans, but in general, animals perceive fewer colors. The retina of the eye contains two types of light receptors: rods and cones. All mammals have more rods than cones and animals have more than humans. For example, humans have nine rods/cone while horses have 20 rods/cone. Cones perceive objects best in bright light and can differentiate colors. The area centralis or visual streak contains the highest concentration of cones and the lowest concentration of rods.

Humans have three types of cones which permit trichromatic color vision (tones of red, green, and yellow). Most domestic animals, that are active during daylight, have two types of retinal cones and dichromatic color vision (yellow and blue). They cannot distinguish colors in the range of 510 to 590 nm, red wave length. Dichromatic color vision in animals is similar to humans with red-green color blindness. Animals with dichromatic vision appear to see blue and yellow best, and have trouble perceiving red and green. With dichromatic vision, red is dark and green is light gray. Dichromatic vision may aid in seeing sudden movements and objects in low light. Nocturnal mammals may be unable to distinguish colors.

Reptiles and tropical birds have four types of retinal cones and may perceive more colors, or colors in dim light than humans can see. Birds can see ultraviolet, blue, green, and red. Bird vision peaks in the orange red portion of the spectrum.

Night Vision

Retinal rod cells are responsible for magnifying light impulses. Rods are able to detect low

intensity light, motion, and differentiate shades of grey, but they provide poor resolution. Most domestic animals, especially nocturnal foragers (horses) or predators (cats), have many more rods than do humans. Species that are scoptic (has vision in dim light) or nocturnal also have a tapetum lucidum (reflective structure in the retina that increases the gathering of light). This results in superior night vision and more intense differences in greys, plus better detection of motion. Horses and most other grazing animals are believed to see approximately up to four times better at night, after accommodation to lighting, than can humans. The tapetum increases light detection at night up to seven times in cats.

Swine have forward placed eyes, round pupils, and no tapetum lucidum. They are also dichromats. Hogs are nearsighted and cannot see well in dim light. Their depth perception is good for close objects which aids their quest for food on forest floors.

Pupil shape affects concentration of visual light. Diurnal species have round or horizontal pupils. The vertical pupil slit in cats provides some protection from bright light, but is able to quickly dilate in rapid darkness.

Now, let's recap the key points to remember from today's episode:

- The vision of predator animals is considerably different than the vision of prey animals
- A species' vision contributes much to why they exhibit a lot of their behaviors
- Most animals see better in low light than humans but perceive fewer colors.

More information on animal handling is available in my book, *Animal Handling and Physical Restraint* published by CRC Press. It is also available on Amazon and from many other fine book supply sources.

Additional information is available at www.betteranimalhandling.com

Don't forget serious injury or death can result from handling and restraining some animals. Safe and effective handling and restraint requires experience and continual practice. Acquisition of the needed skills should be under the supervision of an experienced animal handler.

References

1. Gilger BC. Equine Ophthalmology. 2nd ed. Elsevier, New York, 2010
2. Murphy J, Hall C, Arkins S. What horses and humans see: a comparative review. Int J Zool 2009;2009:1-14.
3. Timney B, Macuda T. Vision and hearing in horses. J Am Vet Med Assoc 2001;218:1567-1574.