An introduction to how dogs see

What is this note about?

This note provides guidance on how dogs see in comparison to humans, including suggestions about how these differences might affect dog handling and training.

Who is this note relevant for?

All dog handlers, trainers, care staff and personnel involved with working dogs.

Introduction

There is a common acceptance that, in most situations, dogs have 3-8 times poorer vision than humans. This note covers the main ways that dog vision differs from human vision, and how this may affect their responses. For a more detailed review of dogs' vision, see [1].

Low-light vision

One situation in which dogs' vision outperforms humans' is under low-light levels. To do this, dogs have a number of adaptations:

- A larger pupil size (up to 10 mm compared to humans' 8 mm), allowing more light to enter the eye.
- A larger number of rod cells in their retina. Rods are a type of light sensitive cell that work in low-light levels, and are important for seeing size, shape and brightness.
- A tapetum lucidum, which reflects more light into the eye and enhances low-light vision (Figure 1).

These adaptations mean that dogs can see in darker conditions than humans.

Figure 1: The tapetum lucidum is visible as a greenish reflective area in the centre of the eye, helping the dog to see better in darker environments. *Third party image reproduced with permission from P. Baumber.*

Dog vision vs. human vision

Compared to humans, dogs have:

- Better low-light level vision;
- Slower adaptation to changing light;
- Worse visual acuity (sharpness);
- Less colour vision;
- Limited depth perception;
- A different visual perspective;
- Potentially better motion perception abilities.

Adapting to changing light

Light adaptation is the ability to become used to different brightness levels, including the time taken to see clearly when moving from dark to bright light conditions, or vice versa. When exposed to a bright light, all of the most light-sensitive cells (rods) in the eye temporarily stop working, and other cells (cones) take over. However, this takes some time, causing dazzling. This can be temporary, but if the light is too bright it can cause permanent damage to vision. Since dogs have more rods and fewer cones in their retina than humans, dazzling may be stronger in dogs. The time taken for the rods to work normally again after dazzling is also less in humans (20-30 mins) than in dogs (70 mins). When moving between extreme lighting conditions, dog's vision will be more strongly affected than humans and they may need more time to adapt.

Visual acuity

Dogs have fewer cones in their retina than humans (5% vs. 14%). The number of cones is important for seeing detail in daylight, meaning that dogs' visual acuity (sharpness) is worse – up to 15 times poorer than humans'. Dogs' visual acuity is further reduced by the tapetum lucidum in the retina, which scatters light and

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makes their vision blurrier. Dogs will not be able to see things as clearly as their handler, especially in daylight.

Across dog breeds, the cones and rods are positioned differently in the retina. This means that long-skulled dogs such as German Shepherds have better visual acuity along the horizon, resulting in better movement detection. However, their visual acuity in the central area is poorer which might impact their ability to see things directly in front of them. Although this is not guaranteed as the positions of the rods and cones can vary even within dogs from the same litter. This means that one dog will see things differently to another dog.

Colour vision

Dogs' retinas contain two types of cone pigments which makes them dichromatic, whilst humans are trichromatic because they have three cone pigments. In dogs, one type of cone reacts to long/medium light wavelengths which are yellow hues. The other type of cone reacts to shorter wavelengths which are blue hues (Figure 2). This means that dogs have poor resolution of what humans see as the colours green and red. Instead, dogs see both red and green as yellowish hues, although they can still tell them apart from other colours. Therefore, some colours which appear very different to humans, like green and red, appear very similar to dogs. If different colours are needed for training purposes, blue and yellow are the best to use as dogs can more easily tell them apart.

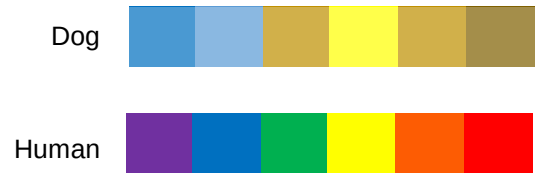

Figure 2: Diagram of dogs' dichromatic colour vision in comparison to humans' trichromatic colour vision.

Depth perception

The area that a dog can see without turning its head (its visual field) is determined by the position of its eyes, ears, snout length and length of fur. Overall, dogs have wider visual fields than humans, and can see between 150-240°, which allows them to more effectively scan the horizon. However, dogs have less binocular overlap between the left and right eye, which is needed for depth perception (Figure 3).

Depth perception is important for calculating the position and distance of objects. Some dog breeds have better depth perception than others, depending on the position of their eyes and skull shape. This means that some dogs may be more likely to misjudge distances.

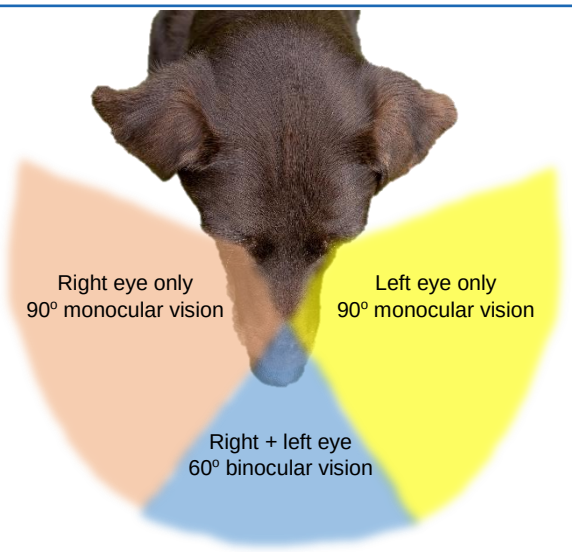

Figure 3: Dogs have a wider visual field but less binocular overlap. *Third party image reproduced with permission from P. Baumber.*

Motion perception

Motion perception is important for dogs. They can detect a moving target from further away (900 m) than a stationary one (585 m).

Visual perspective

The average height of a human is between 165-180 cm, whilst dogs' height to the shoulder varies between 15-110 cm. This means that dogs' vision is orientated more at ground-level than humans, and this size difference may be problematic when navigating through tall vegetation.

Long-skulled dogs may also be more restricted than humans when looking down because their snout can block their vision. To overcome this, dogs need to move their whole head downwards to see the ground.

Aging

Dog eyes appear to age faster than humans. Like humans, they experience lens thickening, hardening and clouding, possibly caused by damage from ultraviolet sunlight. This can make vision become blurrier with age. In addition, dogs' eyes can suffer from a range of diseases including, cataracts, macula degeneration and glaucoma.

While humans tend to become more long-sighted as they age (close objects become blurry), dogs become more near-sighted (distant objects become blurry).

Top tips for considering dogs' vision

- ✓ Ensure that dogs have enough time to adjust to changes in light levels before working.
- ✓ Avoid dazzling dogs with bright lights such as torches.
- ✓ Ensure that dogs are given enough time to navigate obstacles or gaps, as they may be more likely to misjudge distances.
- ✓ Consider that dogs will be able to see some things that a person can't in darker environments.
- ✓ Consider that dogs may not be able to see some things that a person can in brighter environments. Older dogs in particular may struggle to see things that are further away.
- ✓ To improve the chances of a dog seeing something, move it around and use blue or yellow colours.

Associated guides and information

[1] Barber, A.L.A., Mills, D.S., Montealegre-Z, F., Ratcliffe, V.F., Guo, K. & Wilkinson, A. (2020). Functional Performance of the Visual System in Dogs and Humans: A Comparative Perspective. Comparative Cognition & Behavior Reviews, 15. doi:10.3819/CCBR.2020.150002E

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