If we can see it, why can't they?

Lily Edwards-Callaway, PhD
Colorado State University

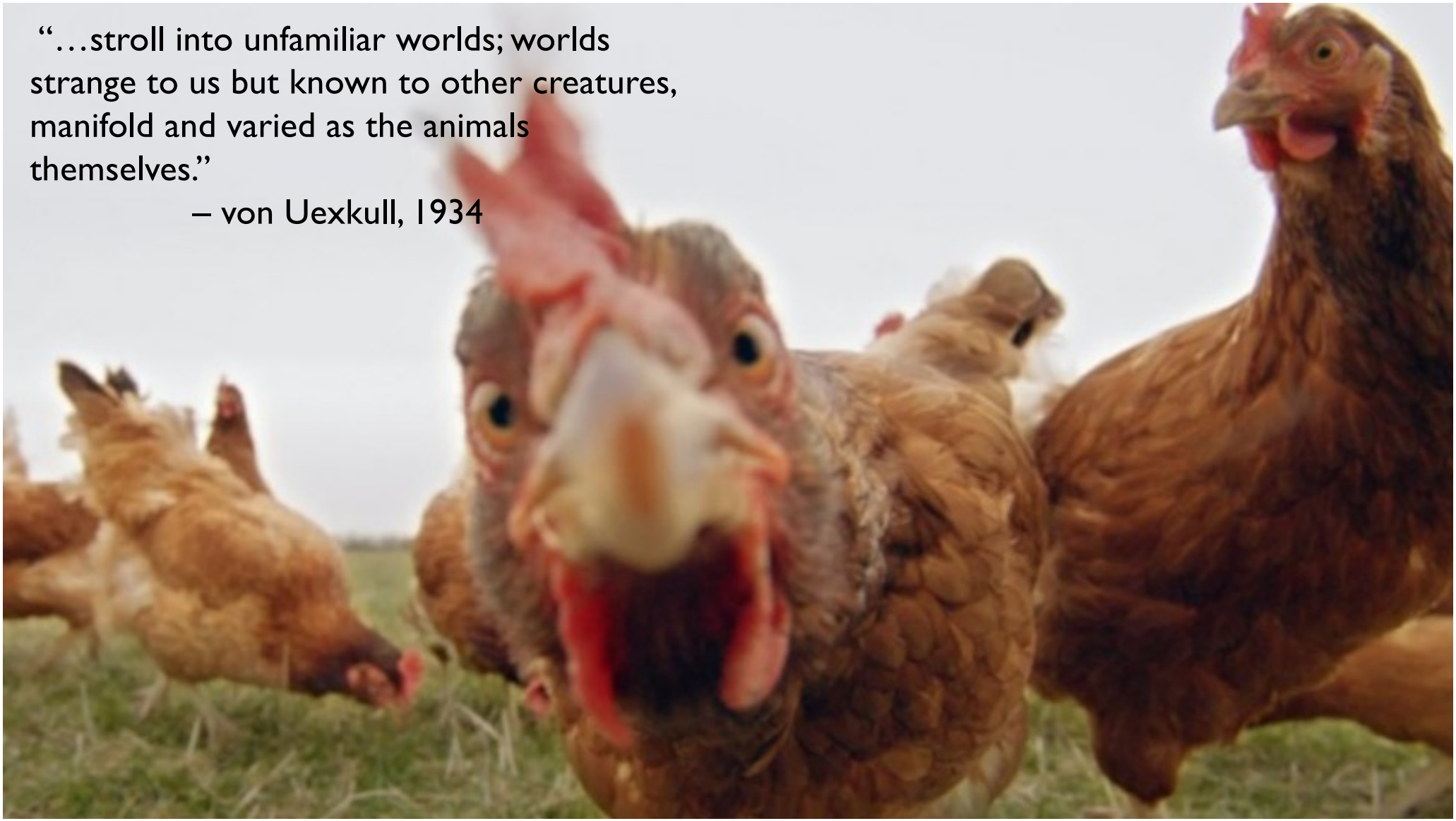

"…stroll into unfamiliar worlds; worlds strange to us but known to other creatures, manifold and varied as the animals themselves."
– von Uexkull, 1934

FIG. 9a
A village street, photograph

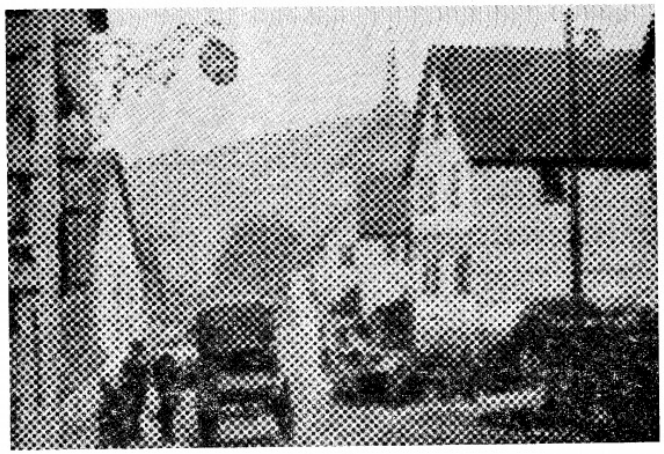


FIG. 9b
The same village street, photographed through a screen

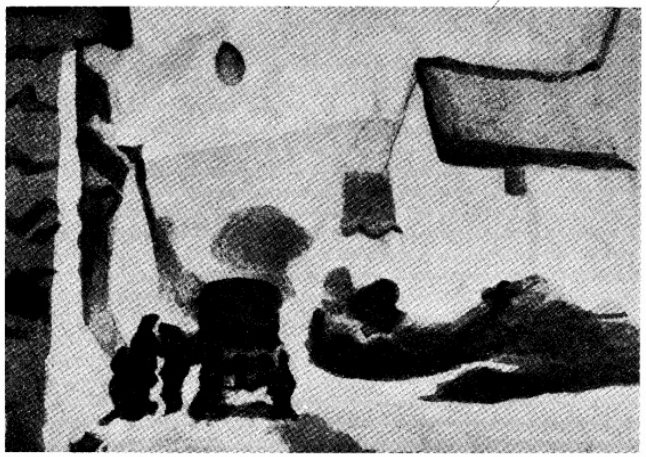


FIG. 9c

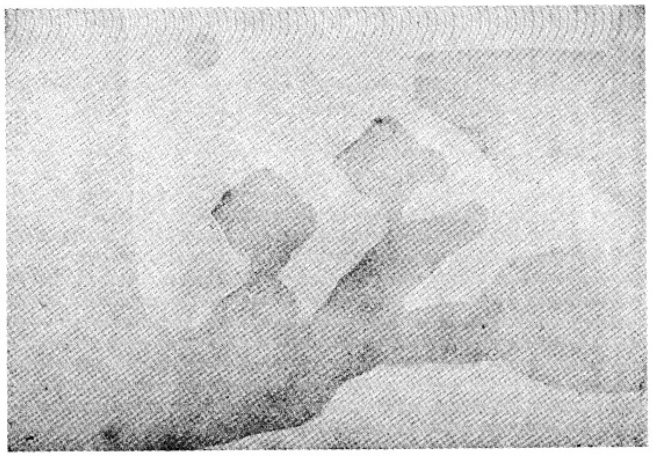


FIG. 9d
The same village street, seen by a mollusc

Von Uexkull, J. (1934). A Stroll through the Worlds of Animals and Men. In C. Schiller (ed.), Instinctive Behavior, New York, International Universities Press, 1957.


“umwelt” = the sensory
world of an organism

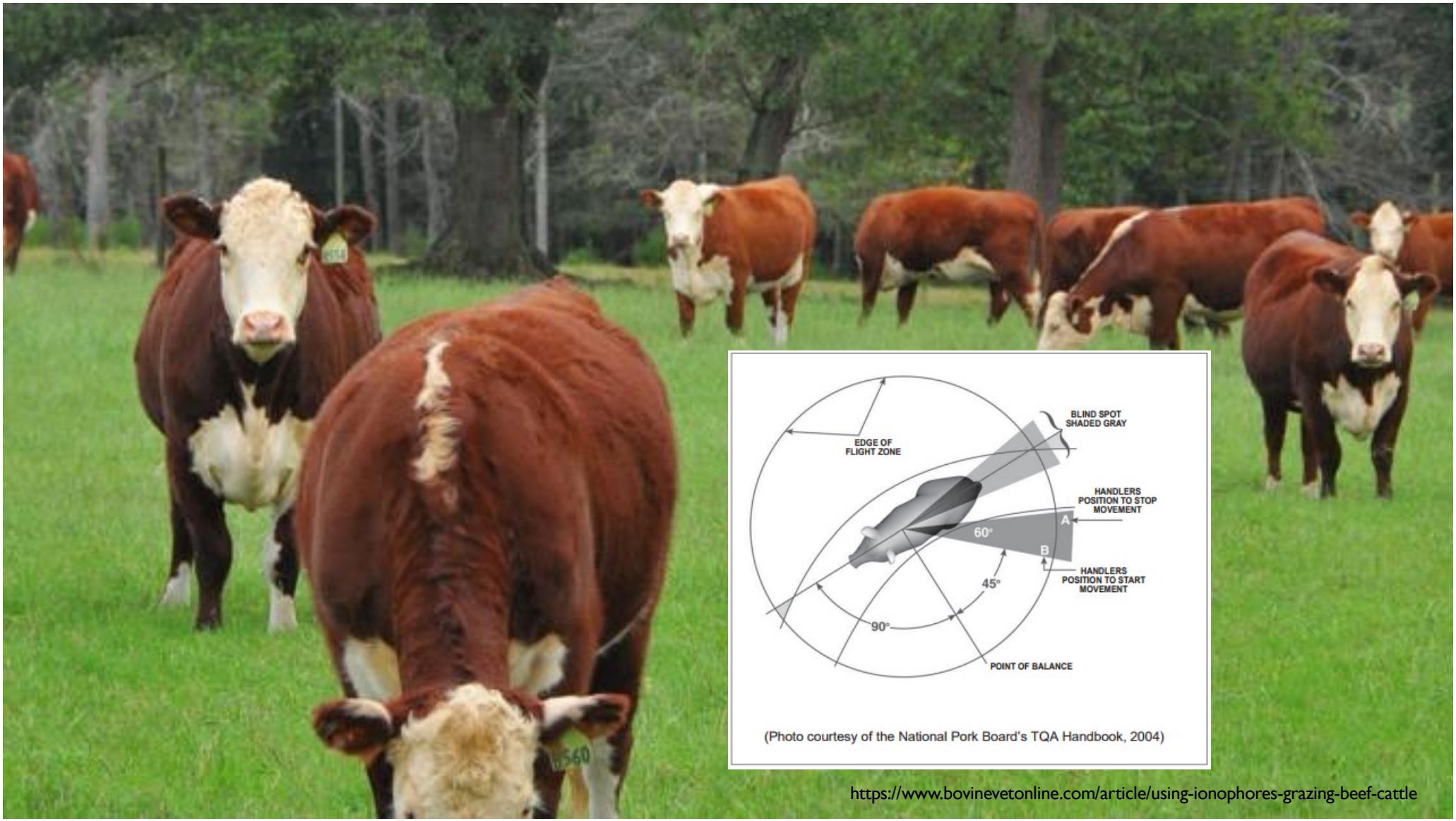
Eye see you – cattle vision

predator vs prey

predator vs prey

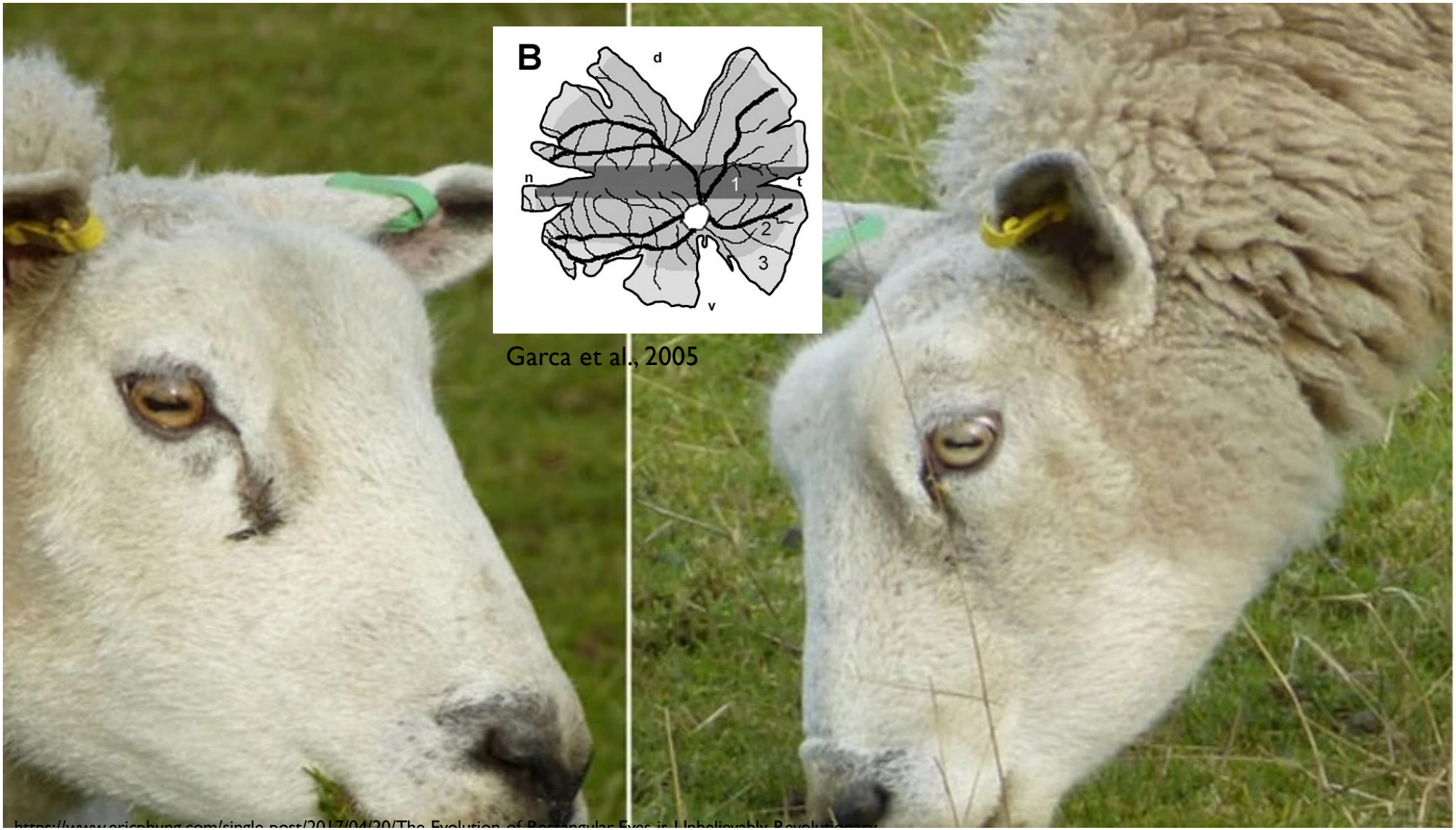

Prey species scan their environment to watch for potential dangers
http://www.42evolution.org/love-in-a-time-of-prozac-how-did-our-emotions-evolve/


Vigilance behavior is motivated by fear..
https://www.bovinevetonline.com/article/using-ionophores-grazing-beef-cattle
http://www.costumes.net/deluxe-scary-werewolf-costume.html



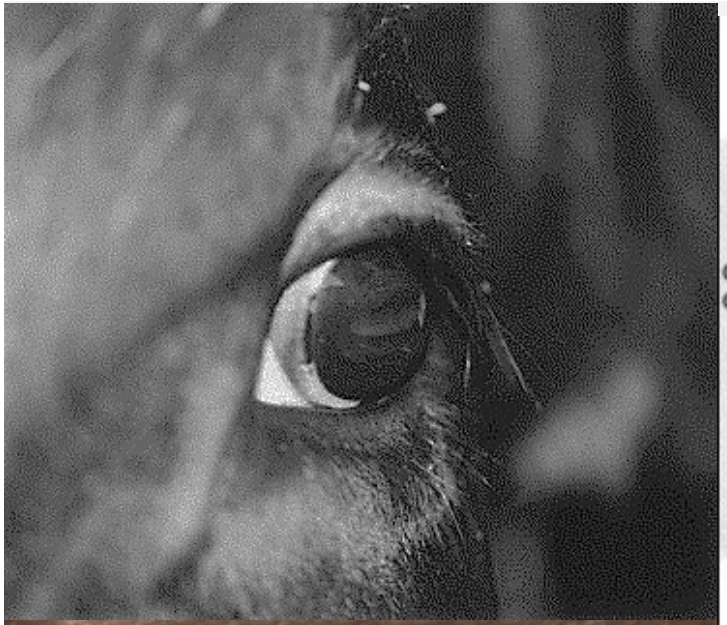
(Photo courtesy of the National Pork Board's TQA Handbook, 2004)

https://www.bovinevetonline.com/article/using-ionophores-grazing-beef-cattle



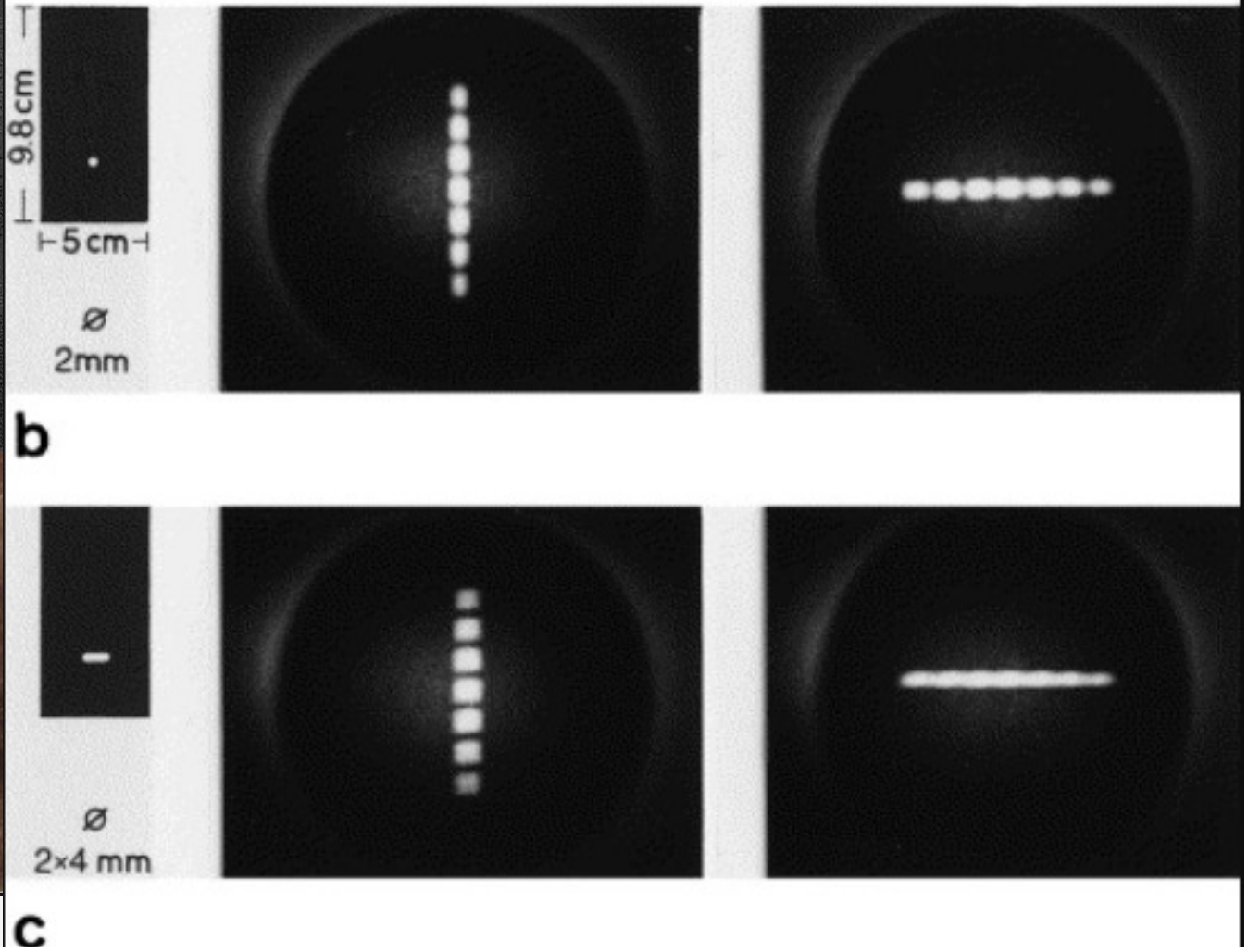
Garca et al., 2005

https://www.ericphung.com/single-post/2017/04/20/The-Evolution-of-Rectangular-Eyes-is-Unbelievably-Revolutionary



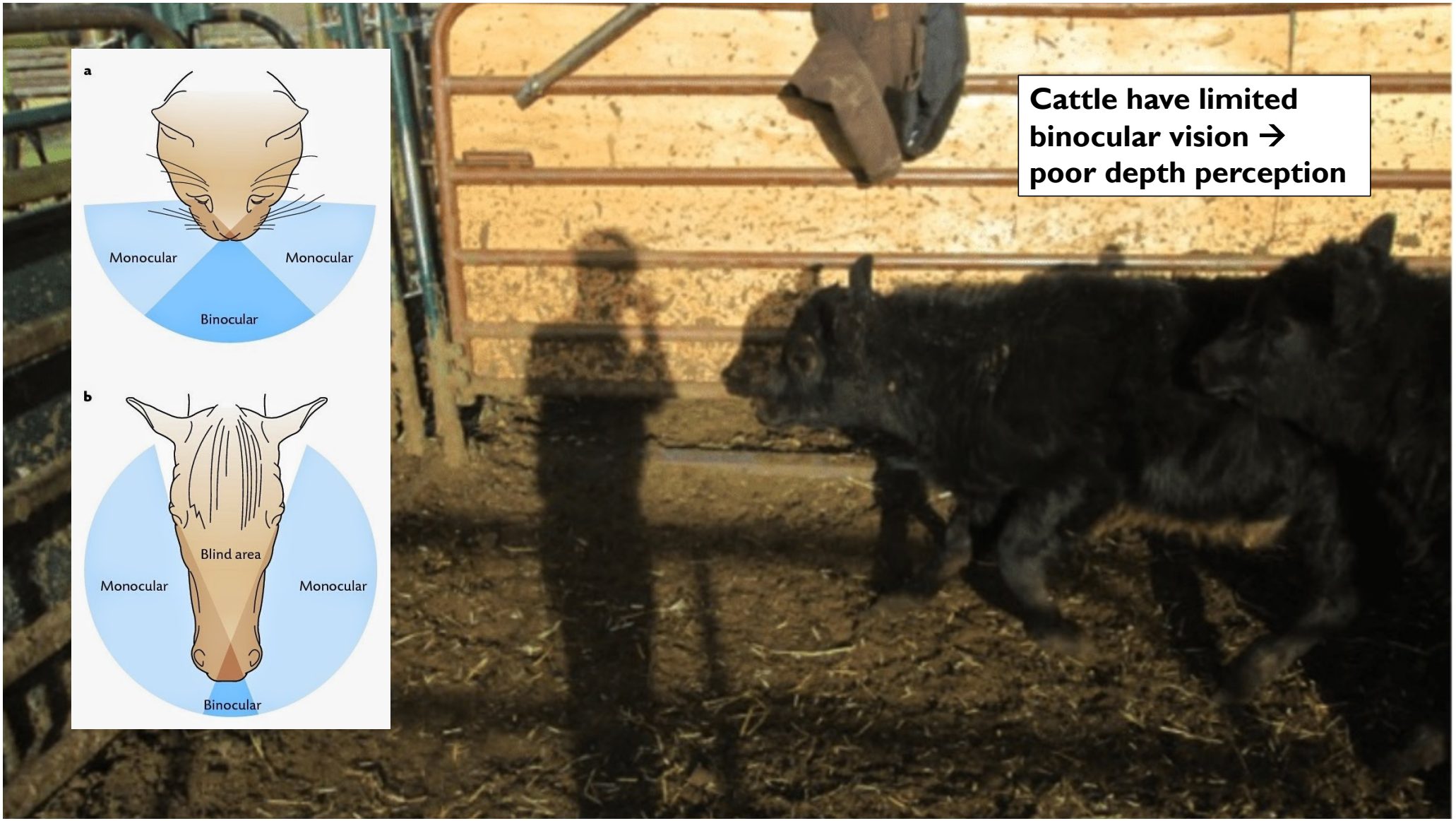
Rehkämper et al, 2000

Cattle are good at identifying things in a vertical orientation (i.e. predators on the horizon).



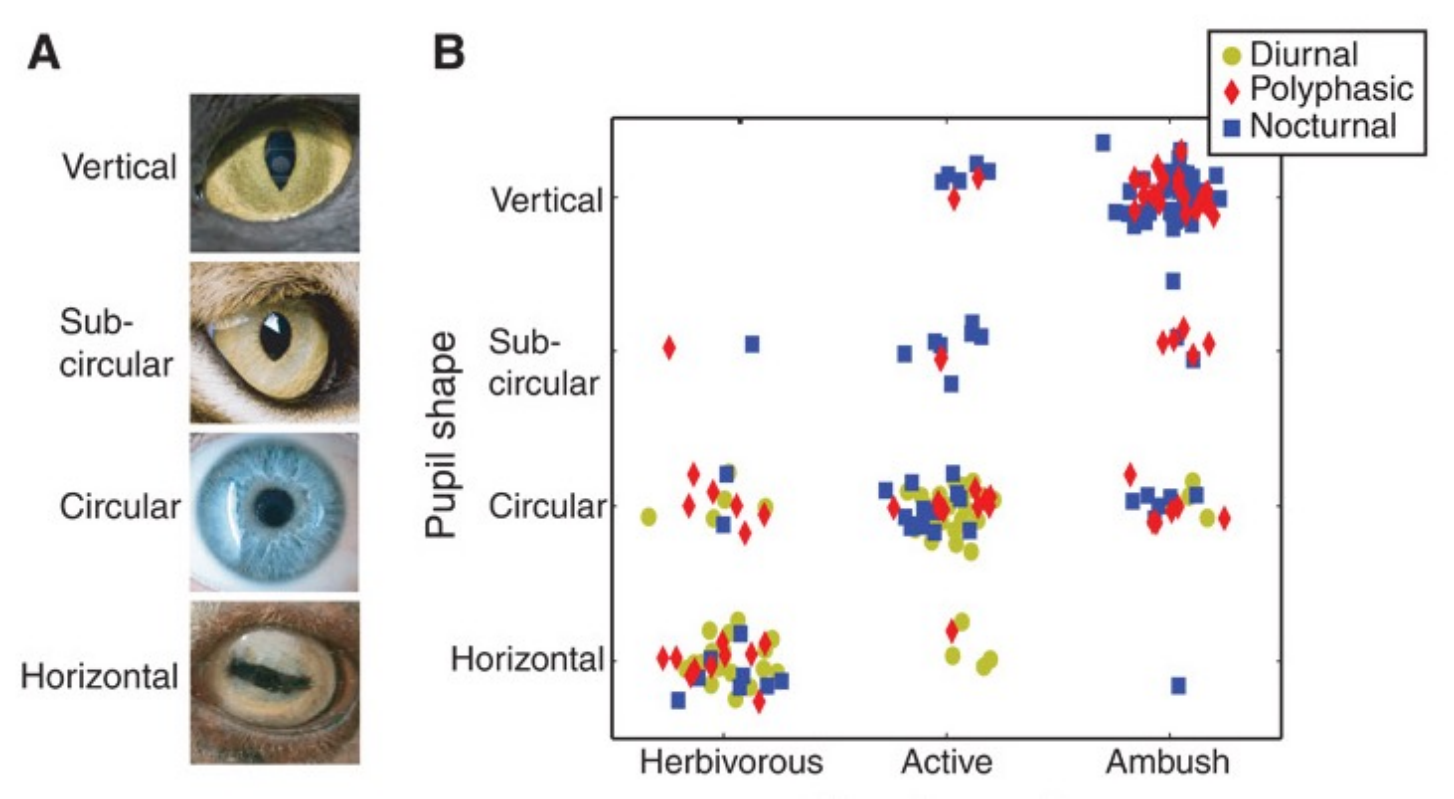
What do you see?

Imagine if you didn't have great depth perception!

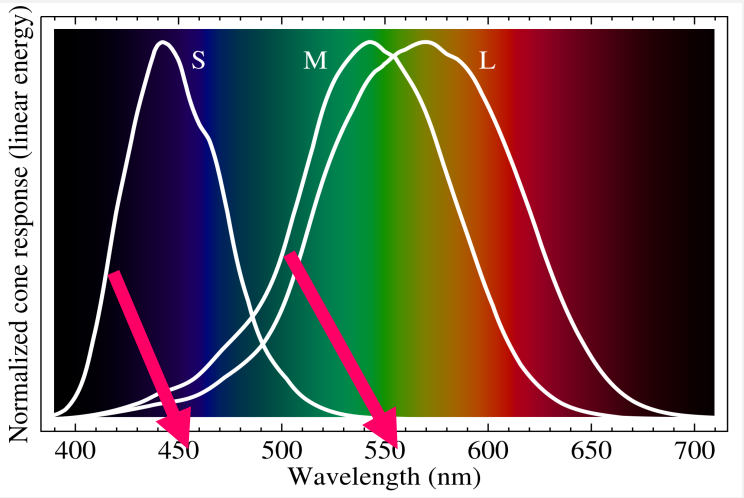

a
Monocular
Monocular
Binocular
b
Blind area
Monocular
Monocular
Binocular
Cattle have limited binocular vision → poor depth perception


www.grandin.com

Herbivorous (prey) animals are very likely to have horizontal pupils, and most diurnal predators have circular pupils. Additionally, nocturnal and polyphasic ambush predators generally have vertical-slit pupils,



Can cattle see color?



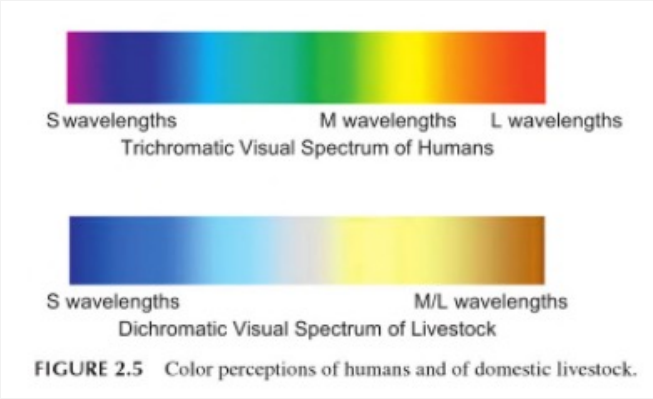


FIGURE 2.5 Color perceptions of humans and of domestic livestock.

Jacobs et al, 1998; Beaver and Hoglund, 2016

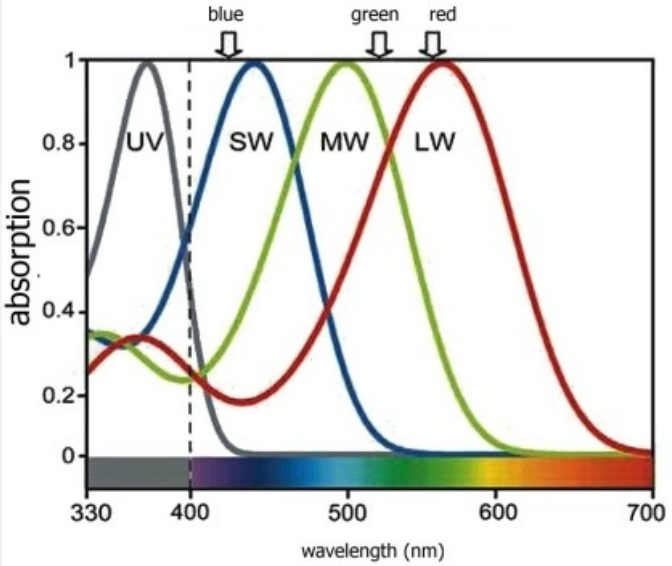
View as seen by humans

View approximating that as seen by horses, cattle, sheep, and goats

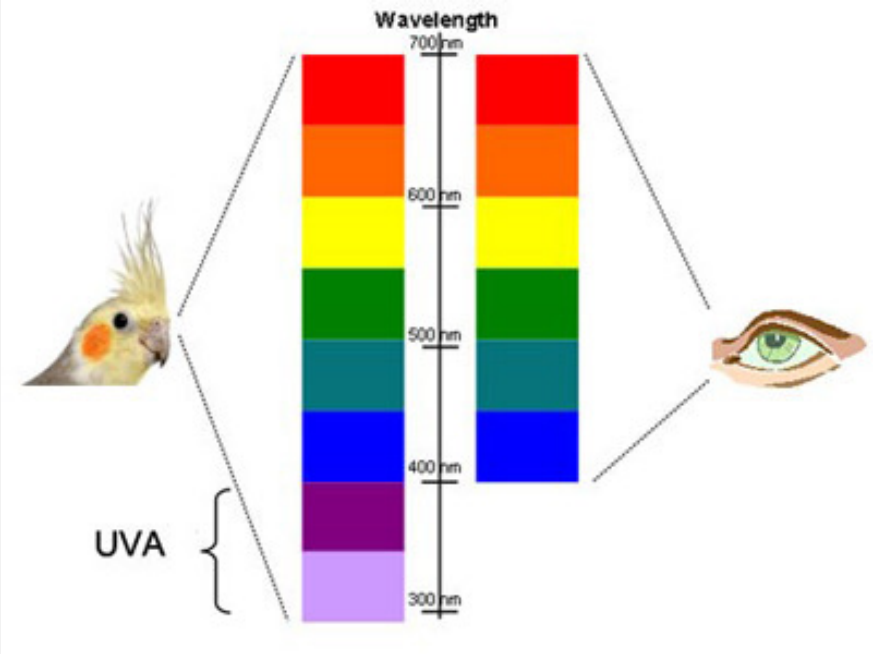
FIGURE 2.4 Concept comparison of the width of visual perception of humans and domestic livestock. *Based on images by Nickolay Lamm about cat vision in consultation with Drs Kerry Ketring, D.J. Haeussler and the Veterinary Ophthalmology Group at the University of Pennsylvania; used with permission.*

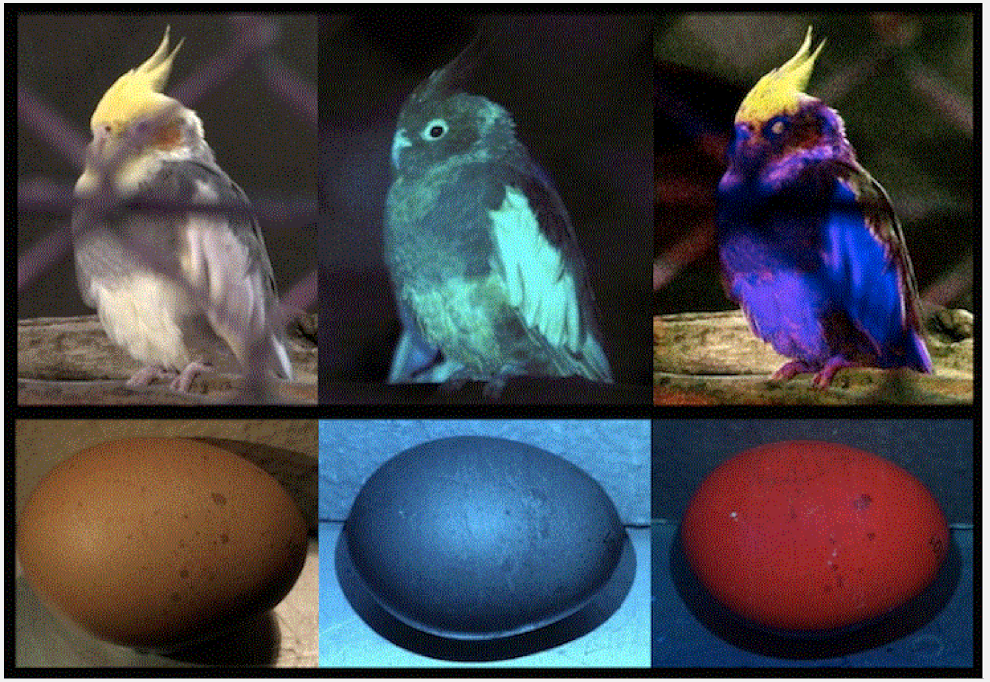
Beaver and Hoglund, 2016

range of wavelengths of light perceived by Gouldian finches



Normalized absorption of the four types of visual pigments in Gouldian finches (Erythrura gouldiae): UV = ultraviolet, SW = short wavelengths, MW = medium wavelengths, LW = long wavelengths. For comparison, wavelengths of peak spectral sensitivity of blue, green and red human cone cells are marked by arrows in the upper part of the figure.





Human view of bird and egg. From K. Schmitt.

UV only reflection.

Simulated bird view with UV.


Picture: DANIEL FOX / CATERS NEWS

Cattle have a tapetum lucidum that helps with night vision.

Dichromats (cattle) are better adept than trichromats (humans) at identifying camouflaged images.

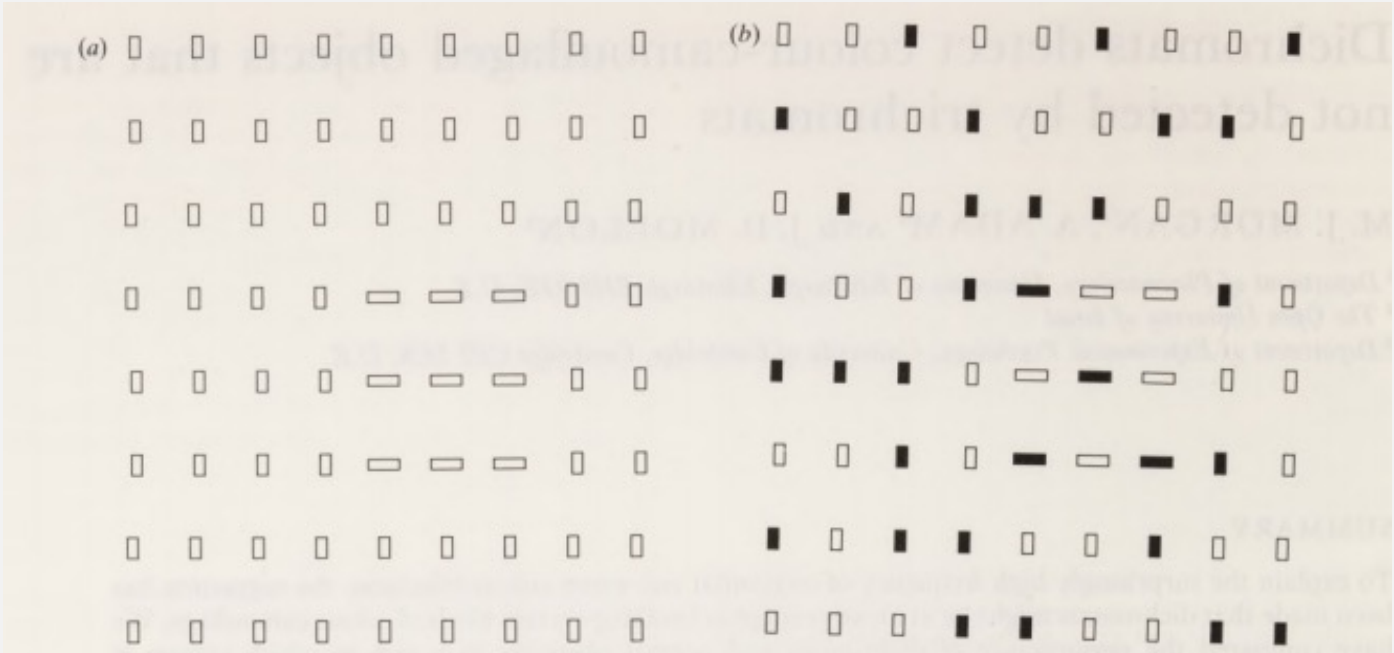


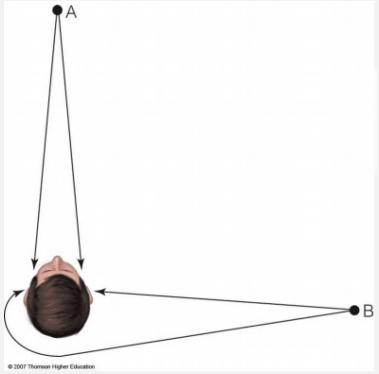
Figure 1. The figure gives a schematic representation of the experimental conditions for investigating the effects of colour camouflage upon textural segregation. The observer's task is to detect the subregion of the pattern in which the elements differ in orientation from the background. In the cases shown, the subregion contains horizontally oriented rectangles, and the background contains vertically oriented rectangles. In the experiment, each element could be one of two different colours: red (open symbols) or green (filled symbols). (*a*) In the control condition all the elements were of the same colour, either red or green; (*b*) in the camouflage condition the elements were randomly coloured red or green. The actual stimuli used in the experiment contained 30×30 elements and the target area consisted of 7×7 elements in one quadrant of the stimulus. The observer's task was to detect the quadrant of the stimulus in which the target area lay.

Morgan et al, 1992

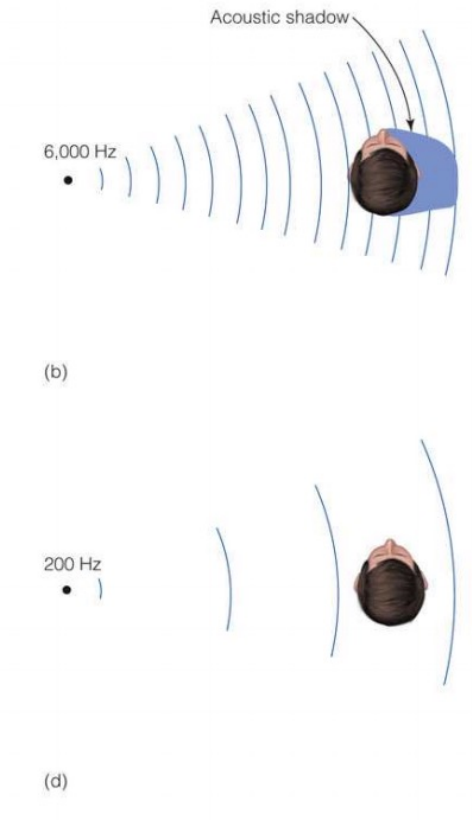
Do you hear what I hear?
- the auditory system


It is difficult for humans to comprehend the benefit of being able to move our ears when listening for sounds

interaural time difference vs interaural level difference



interaural time difference vs interaural level difference



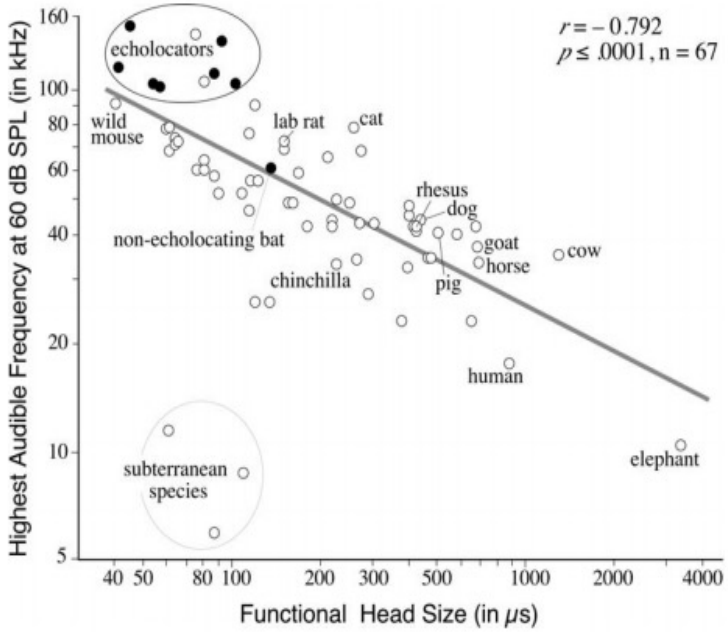


Figure 1. Relation between functional head size and high-frequency hearing (highest frequency audible at 60 dB sound pressure level) for mammals. This relationship is explained by the need of small mammals need to hear higher frequencies than larger mammals in order to use the binaural spectral-difference cue and/or pinna cues to localize sound. Note that the subterranean species (naked mole rat, blind mole rat, and gopher), which do not localize sound, have lost the ability to hear high frequencies. Echolocating bats hear slightly higher than predicted based on their functional head size. Filled circles indicate bats, open circles indicate all other mammals. (The open circles among the echolocators are two species of cetacea.) For references to individual audiograms, see Koay, G. *et al.*, 1998a, and Heffner, R. S. *et al.*, 2003; For tables of the absolute thresholds of mammals, go to the website at http://psychology.utoledo.edu/lch

Relationship between head size and high frequency hearing!

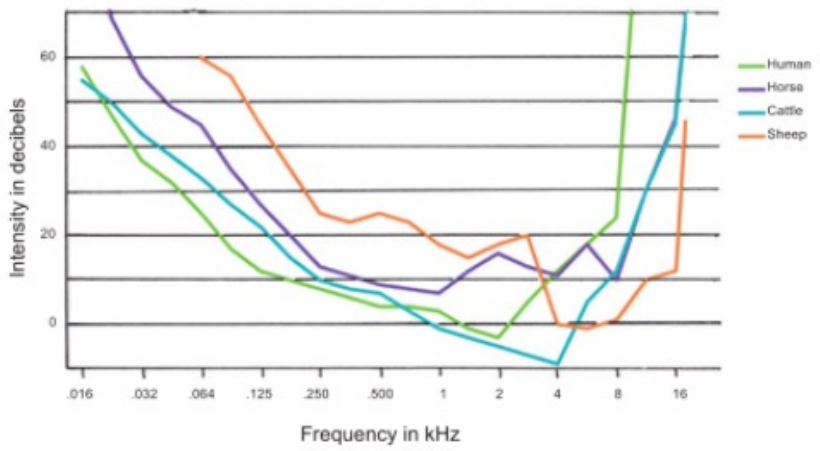
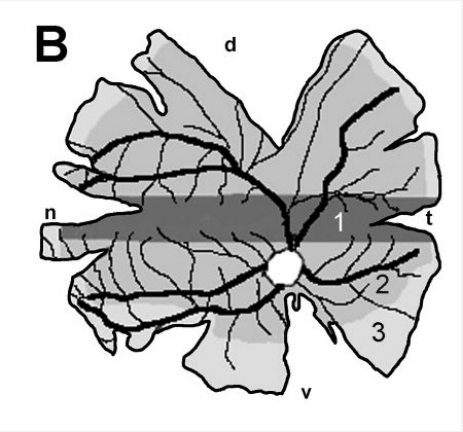


FIGURE 2.6 Comparative audiograms of humans, horses, cattle, and sheep.[54,56]

TABLE 2.1 Range of Hearing for Humans and Livestock[13]

Species	Lowest Frequency Detected (KHz)	Greatest Sensitivity (KHz)	Highest Frequency Detected (KHz)
Humans	0.031	8	17
Horses	0.055	2	33
Cattle	0.024	8	40
Pigs	0.040	8	40
Sheep	0.125	10	40
Goats	0.070	2	40

Beaver and Hoglund, 2016



Garca et al., 2005

What is that smell? – the olfactory system

Olfactory Epithelium

A catacomb at the back of the nasal passage houses sensory receptors.

Humans	*Dogs*
1 in² surface area	**30 in²** surface area
~6 million receptors	**~250** million receptors

cross section

Olfactory Bulb

A brain region that processes signals from the olfactory epithelium. Canine olfactory bulbs are **3 times larger** than those of humans, even though their brains are **10 times smaller**.

Vomeronasal Organ

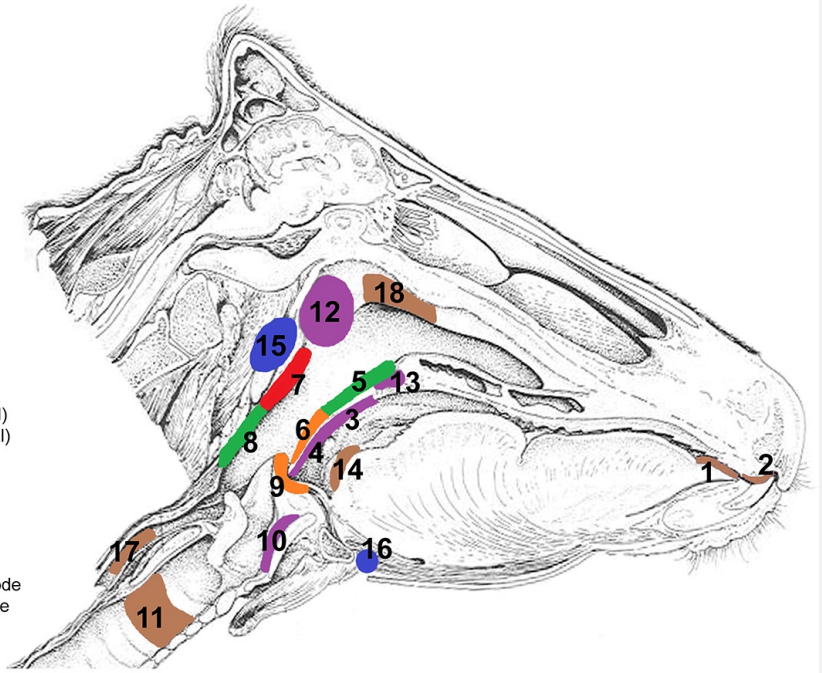
A sensory organ that detects pheremones picked up by a dog's wet nose.

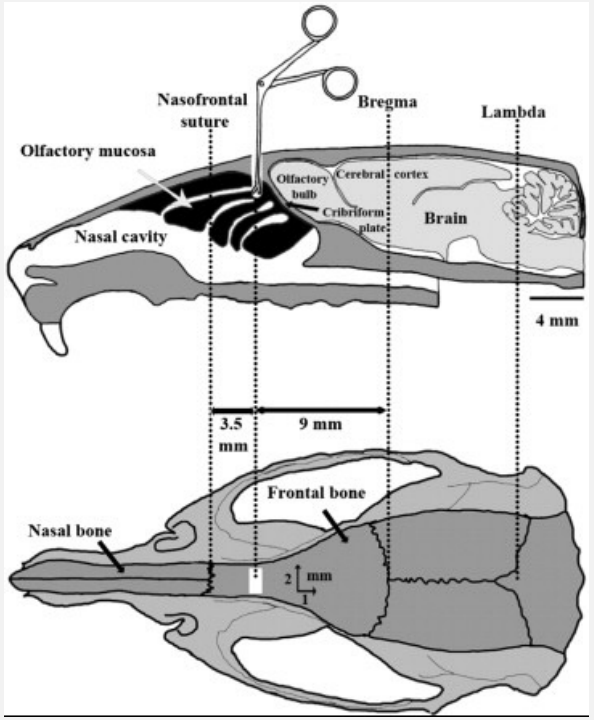
Nostrils

Air is exhaled through the side slits, so it doesn't dilute the scent of incoming air.

Color coding of prevalence
80-100%
60-80%
40-60%
20-40%
0.1-20 %
Negative

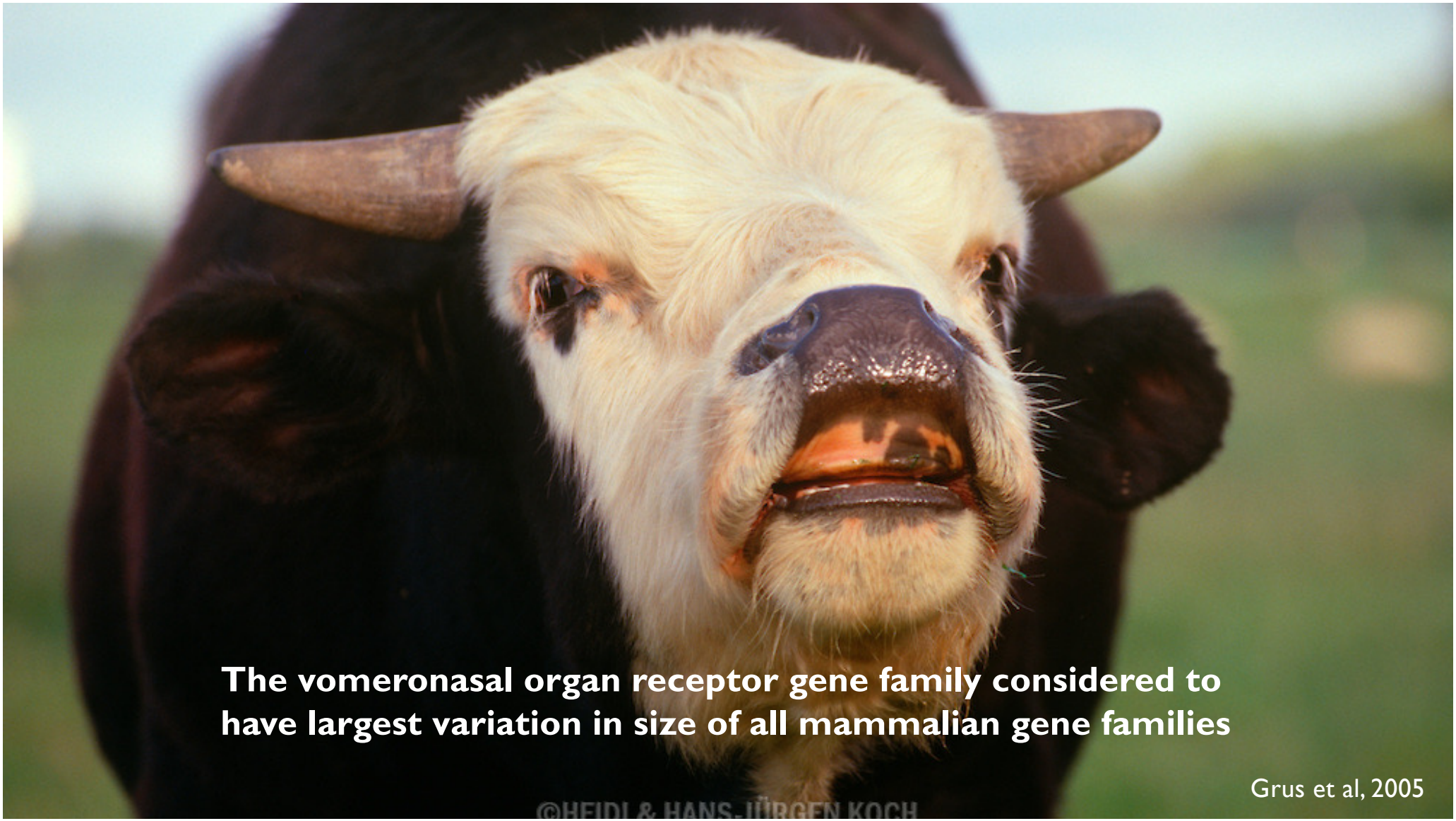
Tissue identification key
1. Tongue (rostral)
2. Dental pad
3. Ventral soft palate (rostral)
4. Ventral soft palate (caudal)
5. Dorsal soft palate (rostral)
6. Dorsal soft palate (caudal)
7. Dorsal nasopharynx (rostral)
8. Dorsal nasopharynx (caudal)
9. Epiglotis
10. Ventral larynx
11. Trachea
12. Nasopharyngeal tonsil
13. Palatine tonsil
14. Lingual tonsil
15. Retropharyngeal lymph node
16. Submandibular lymph node
17. Esophagus
18. Nasal septum





Persistent Foot-and-Mouth Disease Virus Infection in the Nasopharynx of Cattle; Tissue-Specific Distribution and Local Cytokine Expression
Pacheco et al.
https://doi.org/10.1371/journal.pone.0125698

Stamegna et la. (2014). A unique method for the isolation of nasal olfactory stem cells in living rats. Stem cell research. 12. 673-679. 10.1016/j.scr.2014.02.010.

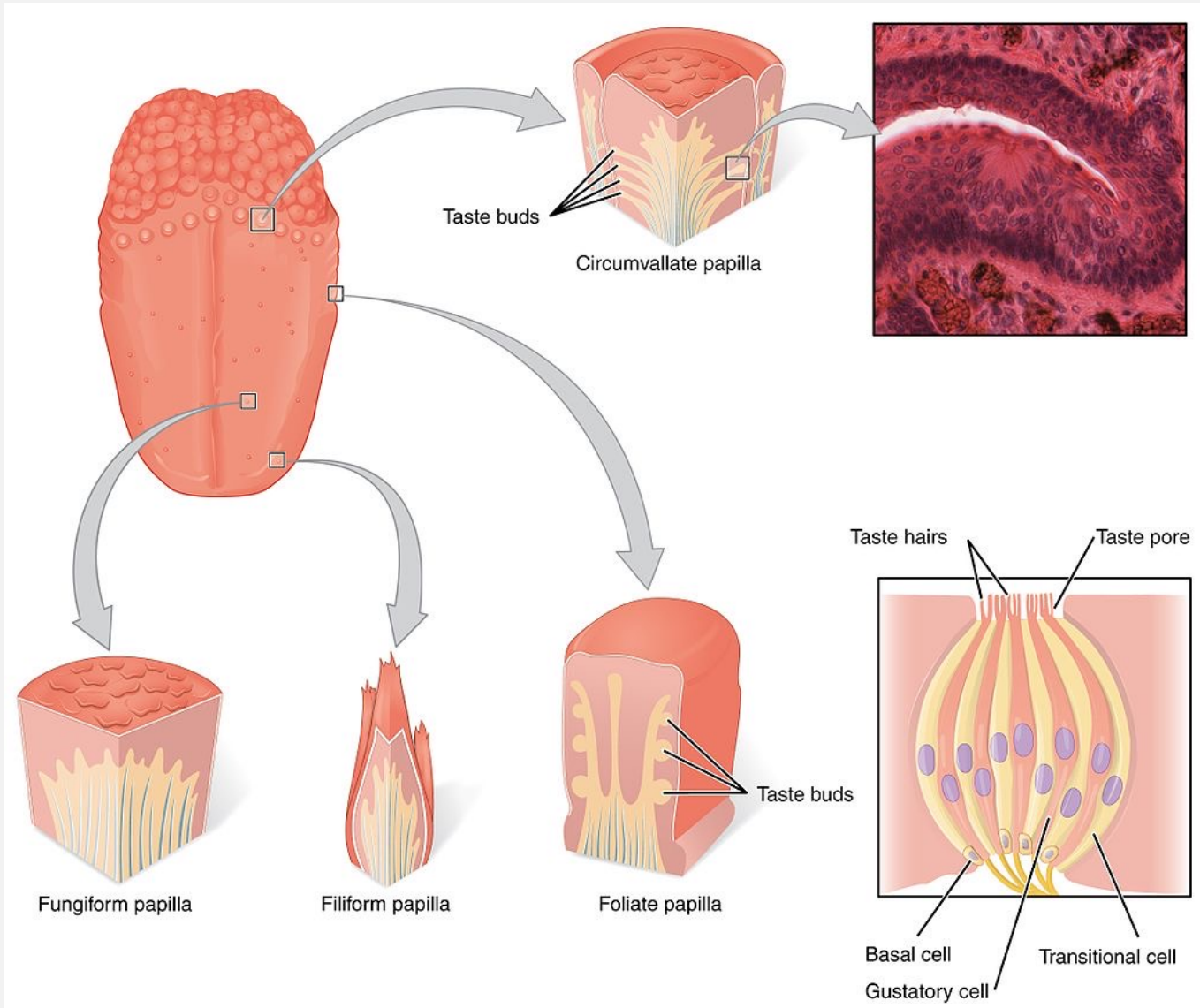


The vomeronasal organ receptor gene family considered to have largest variation in size of all mammalian gene families

Grus et al, 2005

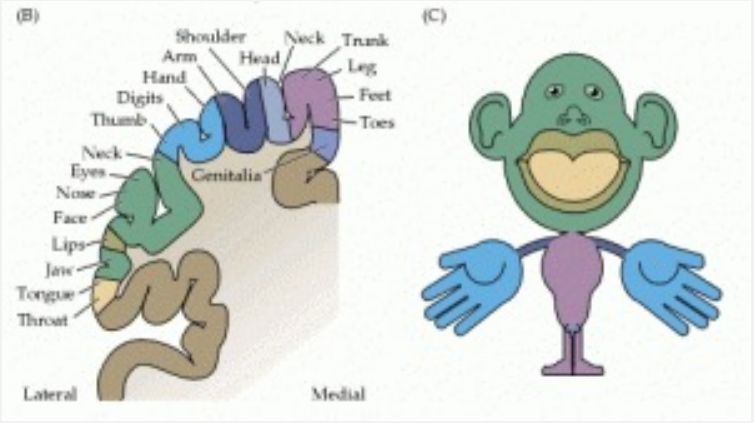

That tastes good?
- the gustatory system

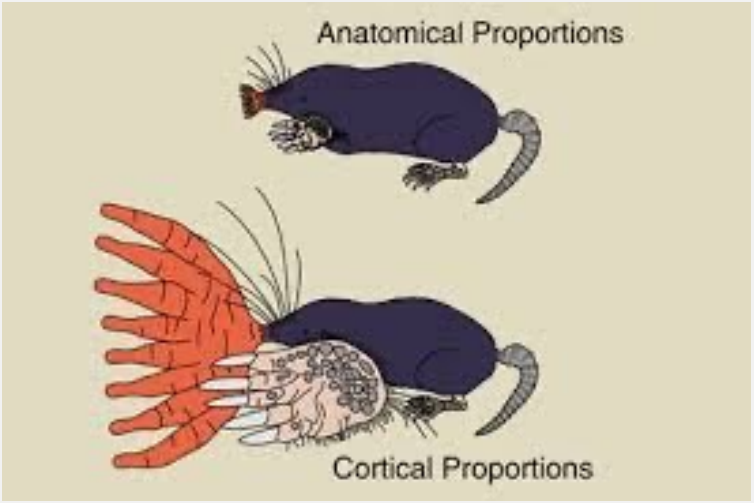
http://mein.salzburg.com/fotoblog/heimat/2009/07/lange-zunge.html


Taste buds
Circumvallate papilla
Fungiform papilla
Filiform papilla
Foliate papilla
Taste buds
Taste hairs
Taste pore
Basal cell
Gustatory cell
Transitional cell


In herbivores, the bitter taste is complex – evolved to prevent the consumption of plant toxins yet plants are also characteristically bitter


Tactile interactions
http://horsesciencehorsesense.com/index.php/allogrooming/

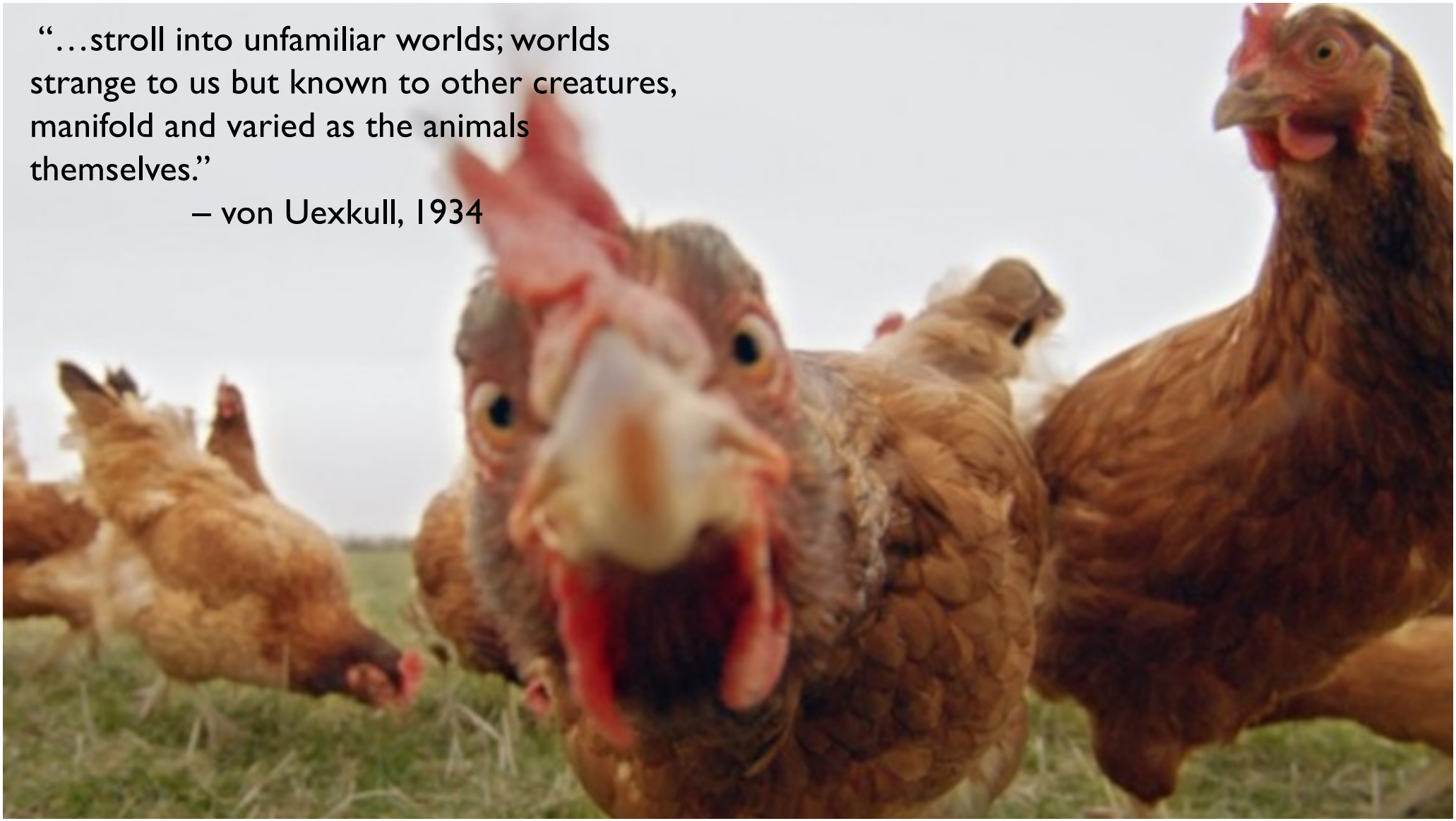




http://blogs.discovermagazine.com/notrocketscience/2008/10/04/learn-to-smell-underwater-with-the-star-nosed-mole/
https://callosalconnoisseur.wordpress.com/2015/09/17/cant-touch-this-unless-youre-a-star-nosed-mole/


https://www.sustainableequitation.com.au/evidence-based-training/bareback-training-why-we-do-it


https://hoards.com/blog-11595-cow-brushes-more-than-just-a-grooming-tool.html


"…stroll into unfamiliar worlds; worlds strange to us but known to other creatures, manifold and varied as the animals themselves."
– von Uexkull, 1934

Questions?

https://geekslop.com/wp-content/uploads/2014/02/image78.png?_ga=2.94079513.528727628.1682373107-79080808.1682373105