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Understanding avian collisions: a birds' eye view

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Why are these a problem to birds?

In the majority of birds (as in ourselves) vision is the dominant sense

"A bird is a wing guided by an eye"

André Rochon-Duvigneaud (1943) "Les *yeux et le vision des Vertébrés"* (Masson, Paris)

What does an eye do?

Provides <u>certain</u> types of information about the environment surrounding an animal

Visual <u>perception</u> is the <u>interpretation</u> of that information

Important general properties of all sensory systems

- All sensory systems are *selective* within their own modality
- Sensory systems detect only a small part of the total information that is available
- To gain one type of information may compromise the ability to gain another type of information

Lesser Flamingo

Phoeniconaias minor

We need to develop a birds' eye view of collisions

• A human based view of the problem is misleading

• We must try to appreciate the world "through bird eyes"

• The way in which birds view the world is quite different from our own view

The human view provides just one way of gaining information about the world

What is a bird's visual world compared to ours? 1.

General differences…

Colour vision

- birds maybe able to make more subtle discriminations between colours
- most birds see into the near ultraviolet.

Rock Pigeon *Columba*

Spatial resolution

- birds have different abilities in terms of the detail that they can resolve
- highest acuity occurs laterally, not forwards

What is a bird's visual world compared to ours? 2.

Visual fields: general differences

Humans
Eyes at front of the head
Extensive binocular overlap in direction of travel
Extensive blind areas above and behind head
Region of highest spatial acuity and most acute colour discrimination projects forwards

Birds
Eyes placed laterally in the head
Small binocular overlap in the direction of travel
Extensive visual coverage above and behind head
Regions of highest spatial acuity and most acute colour discrimination project laterally

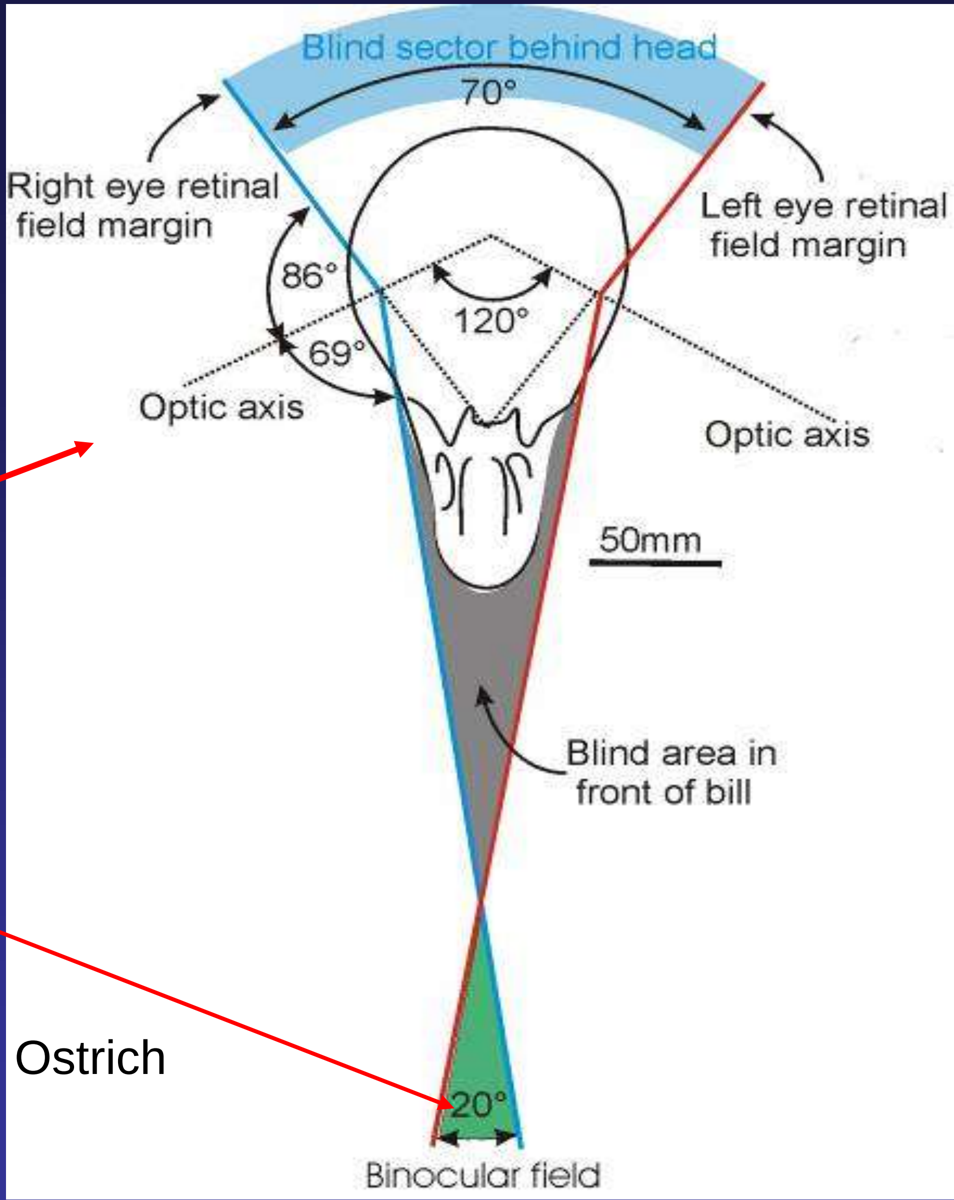
What is a bird's visual world compared to ours? 3.

Visual fields: general differences

Humans	Birds
Best appreciation of relative depth lies ahead in the binocular field and is derived from stereopsis	Binocular/frontal vision is primarily concerned with near tasks, stereopsis is absent in most birds, locomotion is controlled by optic flow-fields
The human visual world is "in front" and humans move "into" it	The avian world is "around" and birds move " through" it

Highest spatial acuity and most acute colour vision is lateral, along the optic axis

Peripheral vision is forward vision



Birds use their lateral visual fields rather than binocular/frontal fields for many key tasks

For tasks requiring high spatial resolution:

• fixate upon a target with lateral field

• behavioural control typically passes to frontal (binocular) vision for final seizure of object/food only at close range.

Examples:

• Thrushes foraging on the ground

• Peregrine Falcons fix prey with lateral visual field and stoop along a curved path holding the item in the lateral field until just before capture when control passes to frontal vision

Birds have lateralised brains and this is reflected in lateralised preferences for different types of task

Rogers, Andrew and Co-workers have shown that birds not only use a lateral field but they have different eye preferences for particular types of task (lateralization of brain functions)

Binocular/frontal vision in birds is primarily concerned with near tasks.

Control of bill in foraging; chick provisioning; nest building.

Not the control of locomotion.

- Binocular fields are not maximised in width

- Control of locomotion is achieved by the use of information extracted from “optic flow-fields”

- Optic flow-fields require the detection of movement not high resolution

- Optic flow-fields give information on the *direction of travel* and *time-to-contact*

When birds are flying in open airspace what are they doing?

What are they using vision for?

- Looking ahead for obstacles?
- Looking below/laterally for conspecifics/predators?
- Looking below for food/habitat patches?

Human collisions exemplify a problem of perception. Even when “looking ahead” humans may “Look but fail to see”

A consequence of perception and attention, not a failure of “vision”

- Well known phenomenon in car driving accidents (familiar habitat, predictable environment).
- In predictable environments we typically travel beyond the “perceptual limit”. We predict that the world will not change (we “know” the environment).
- The rate of gain of information often does not match the perceptual challenge

Humans and collisions?

• Since we are not looking for/expecting to see the hazard we have to be warned ("primed") in order to detect it; we need to be given other information, it is not sufficient to just make the hazard more conspicuous.

A consequence of this is the apparent overload of signs that tells us that there is a hazard ahead.

Adjust the rate of gain of information so that it more closely matches the perceptual challenges of the task

i.e. it is possible to overcome this problem by decreasing speed

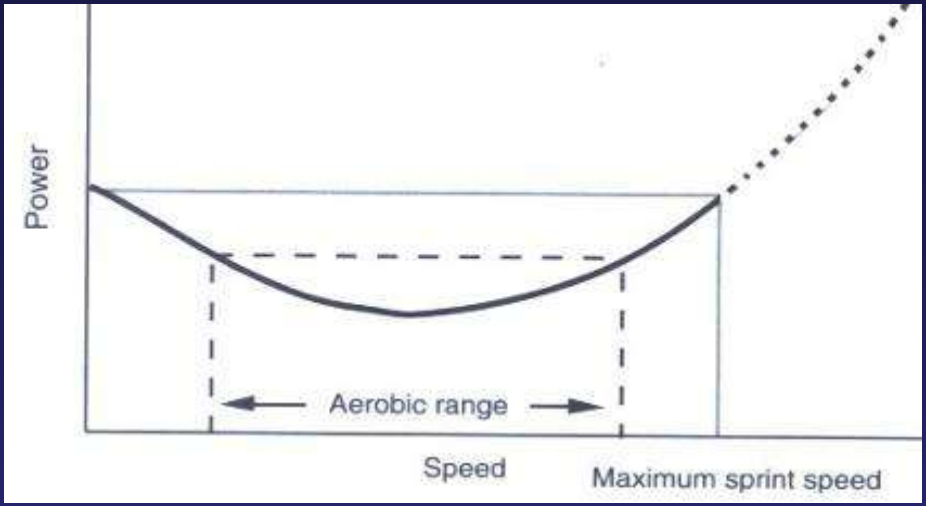
Birds and Collisions

Are there similar perceptual and attentional problems posed by power wires and wind turbines for birds?

Two key questions

1. Can birds adjust their rate of gain of information to meet the perceptual challenge of the environment? Can birds slow down?

2. In open habitats are birds always looking ahead?



Theoretically the aerobic range of flight speed for most birds is restricted.

In practice it is very restricted, especially for birds with high wing loadings

Birds cannot readily slow down to match their rate of gain of information to the perceptual challenges

i.e. Just because the environment restricts the information available (e.g. rain, mist, low light levels) birds cannot fly slower

Do birds sometimes fail to see the way ahead?

Gull-billed Tern

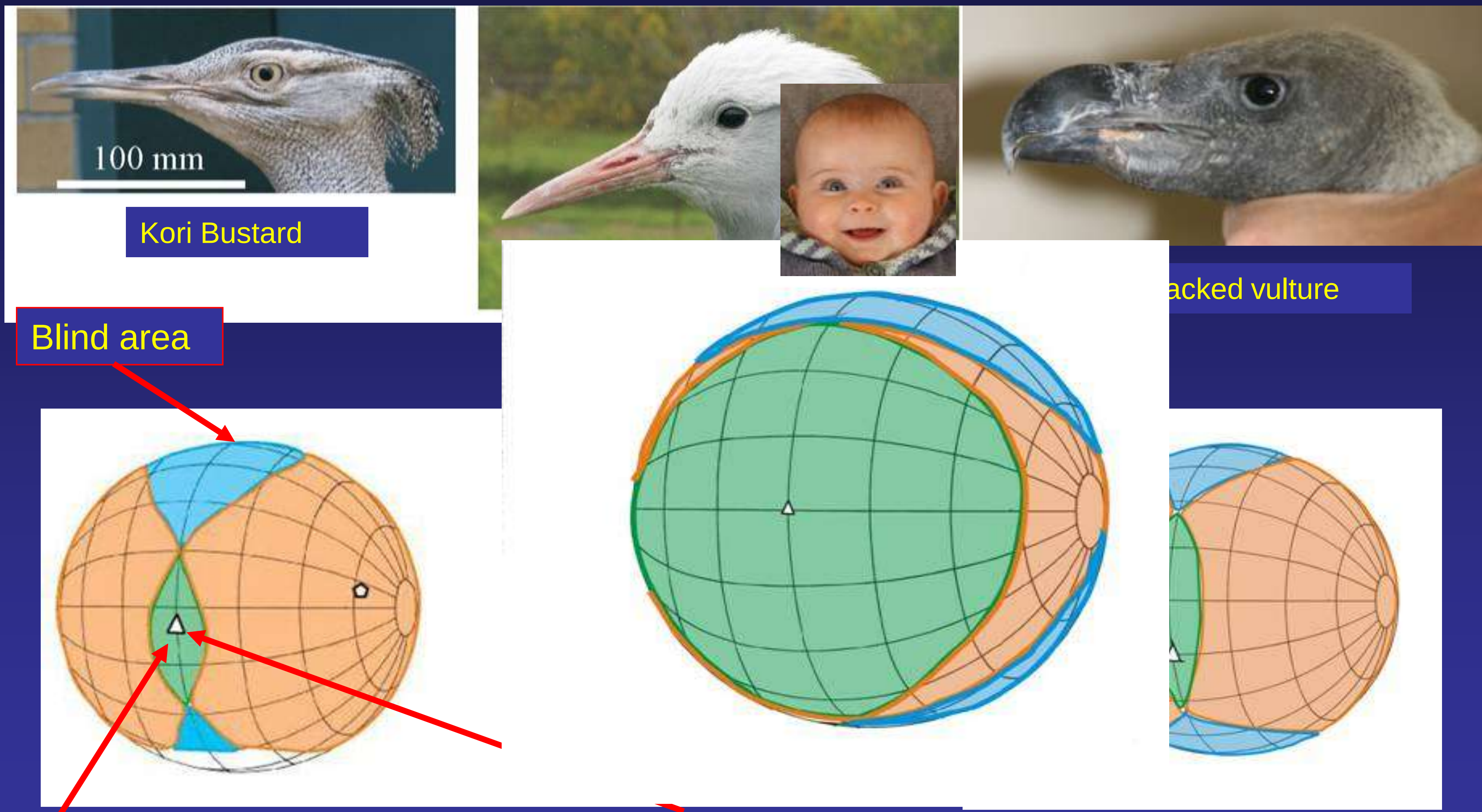
Gelochelidon nilotica

Peregrine Falcon

Falco peregrinus

White-backed Vulture *Gyps africanus*

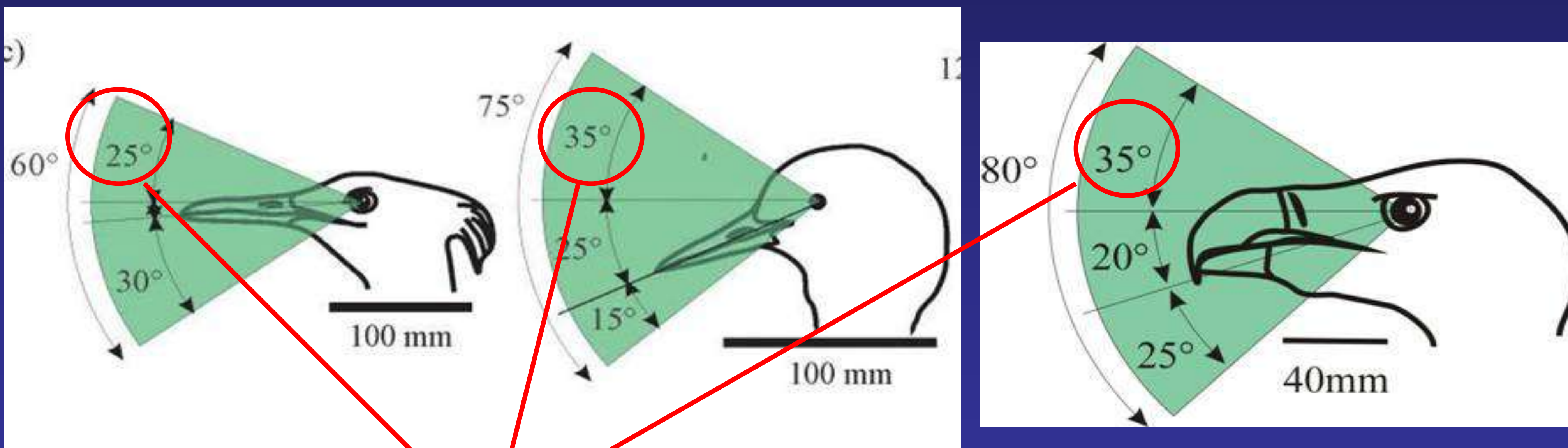
Collision prone species may not always be looking ahead



Blind area

Binocular area

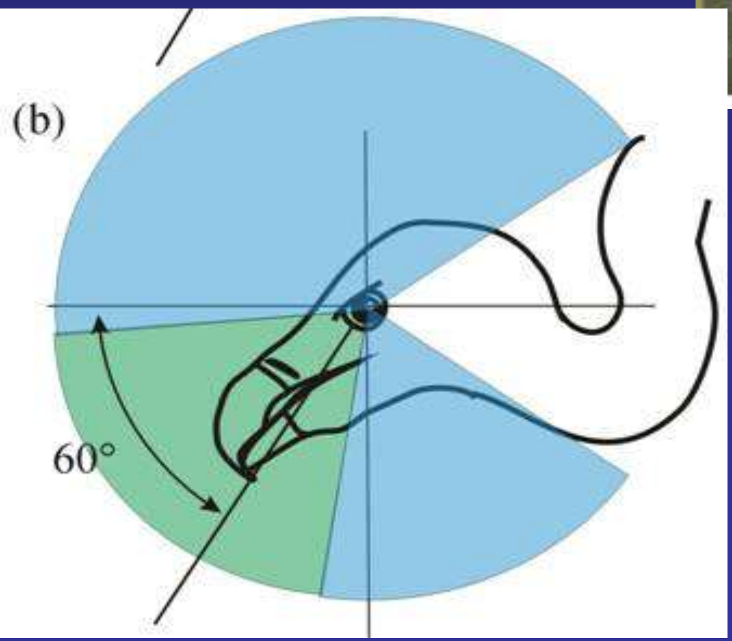
Direction of bill tip in flight



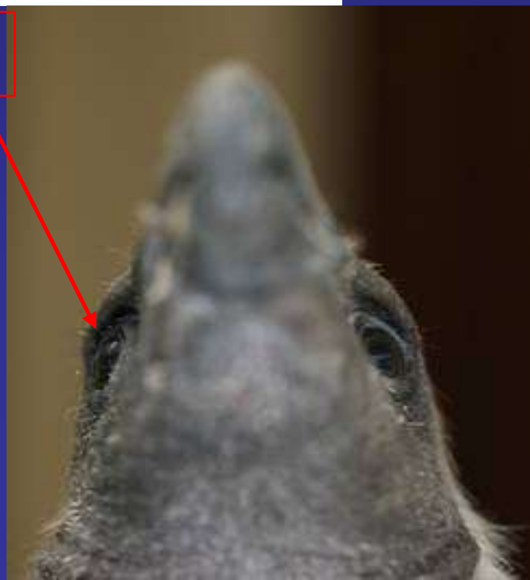
Small forward pitch head movements can render birds blind directly ahead

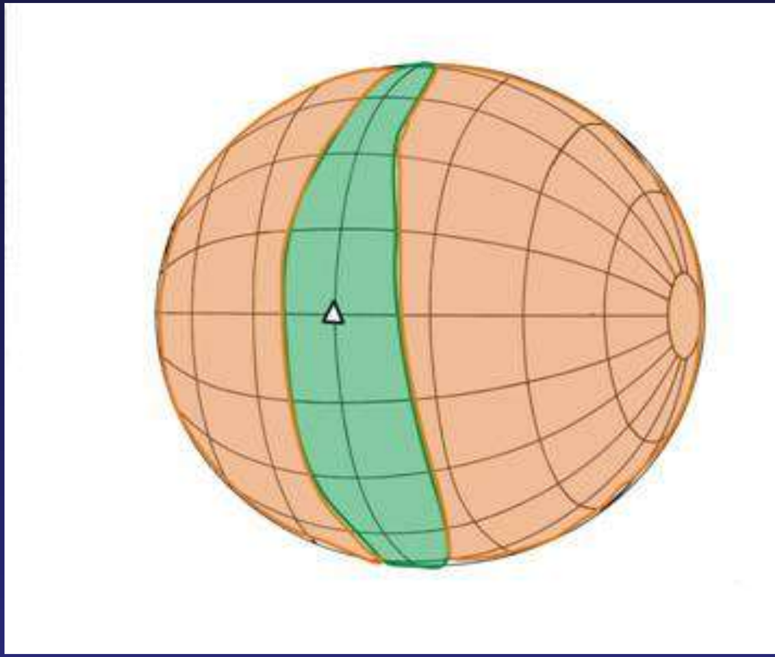
In flight

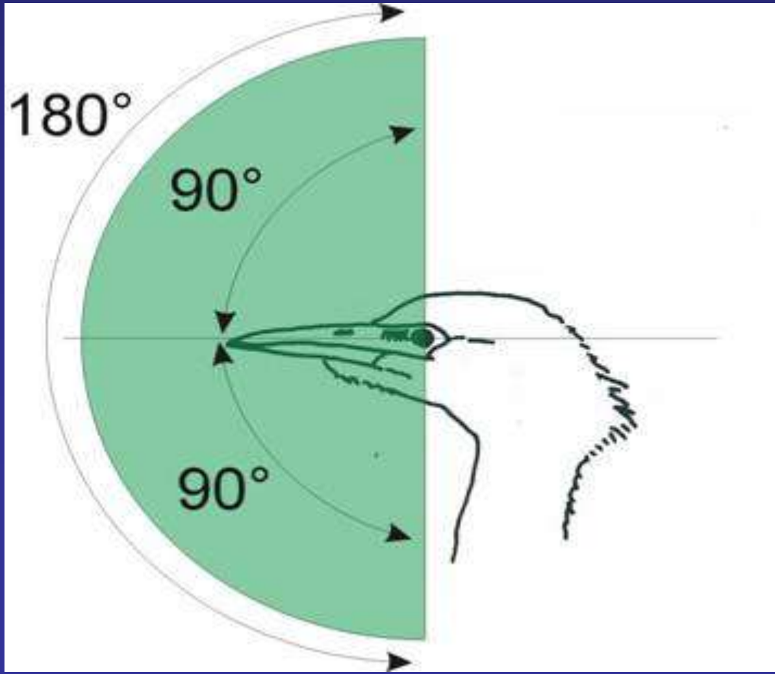
- Blind directly ahead
- Can see ground directly below
- Can see other vultures laterally, social foraging
- Avoids imaging the sun



Sun shades







Cattle egret *Bubulcus ibis*

Some birds gain comprehensive vision of the frontal hemisphere

Birds & collisions: need to acknowledge that…

- In flight some birds may be blind ahead of them; turning the head to look downwards or laterally may not be unusual
- Frontal vision is not high resolution vision
- Frontal vision may be tuned for the detection of movement rather than spatial detail (optic flow field for direction of travel, time to contact)
- Birds may employ lateral vision for the detection of conspecifics, foraging opportunities, predators

Birds & collisions: need to acknowledge that…

- Birds in flight may predict that the environment ahead is not cluttered. Even if they are “looking ahead” they may fail to see an obstacle

- Birds may not predict obstructions, perceptually they have no “prior” for power wires or wind turbines

- Birds have only a restricted range of flight speeds that can be used to adjust their rate of information gain concerning objects that lie ahead

Solutions to collisions?

- Do not assume that obstacles can be made more conspicuous
- Stimuli used to draw attention to the actual obstacle should incorporate movement and be large, well in excess of the size calculated to be detectable based upon acuity measures
- “warn” birds well in advance: prime attention
- assume that birds are more likely to be looking down and laterally rather than forwards
- “divert” or “distract” birds from their flight path: use foraging patches, conspecific models, warning sounds…

Solutions to collisions?

- When planning new obstacles (e.g. Wind Turbines, power lines) place them away from known flight paths, foraging sites, etc.

- There is unlikely to be a single effective way to reduce collisions for multiple species at any one site

- Warning or diversion and distraction solutions may need to be tailored for particular target species

Final thoughts

Remember, my world is not your world.

Take a bird eye view, not a human eye view.

• Martin, G. R. 2011 Understanding bird collisions with man-made objects: a sensory ecology approach. *Ibis* 153, 239-254.

• Martin, G. R. 2011 Through Birds' Eyes: insights into avian sensory ecology. J. Ornithol. DOI 10.1007/s10336-011-0771-5

• Martin, G. R. & Shaw, J. M. 2010 Bird collisions with power lines: Failing to see the way ahead? *Biol Conserv* 143, 2695-2702.

• Martin, G. R. 2009 What is binocular vision for? A birds' eye view. *J Vis* 9, 1-19.

• Martin, G.R., Portugal, S.J., & Murn, C.P. 2011 Perceptual Basis of Vulture Vulnerability to Collisions. Ibis (under review)