


Senses, Brains, and Intelligence

Chapter 7


Birds Aren't People

- UV vision
- Magnetism, polarized light, celestial compass
- Acute, directional hearing
- Birds are very intelligent




Vision

- Up to 3 times better resolution than humans
- Large eyes
 - Ostrich eyes largest of any land vertebrate
- American Woodcock can see 360°
- Many birds use one eye at a time
 - Bob head to gain depth perception




Vision

- Binocular Vision



Vision

- Eyelids
 - Birds have three
 - Upper
 - Lower
 - Nictitating



Heather Uphilldowndale

Magnetic Fields


- Can navigate based on magnetic field detection
 - Small scale movements and migrations
- Unknown how
 - Magnetite-like compounds are found in the nerves and bones in the head
- Magnetite also found in pineal gland, helps determine daily cycles

Hearing

- Territorial Defense
- Mate Choice
- Navigation
- Prey Detection

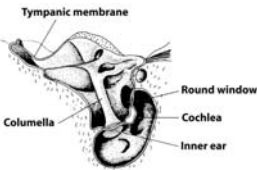
Hearing

- Ear Structure
 - External Ear
 - Lack external skin structure
 - Auricular feathers cover ear opening
 - Ear Funnel
 - Ear Flaps
 - External ear opening/skull asymmetrical



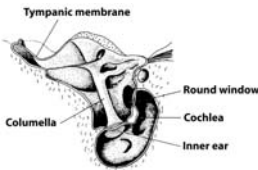
Hearing

- Ear Structure
 - Middle Ear
 - Single bone: columella (stapes)
 - Connects tympanic membrane to the inner ear



Hearing

- Ear Structure
 - Inner Ear
 - Cochlea
 - Fluid filled, coiled
 - Hair cells monitor vibrations
 - Transmitted to brain

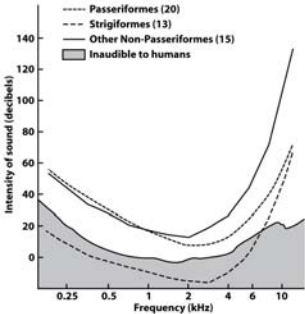


Hearing

- While simpler than mammal ear structure, birds' ears are acoustically comparable

Hearing

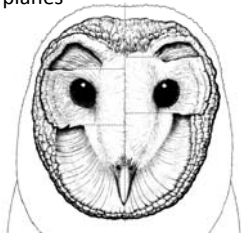
- Hearing Ability
 - In general, birds hear well over fewer frequencies, compared to humans



Frequency (kHz)	Passeriformes (20) [dB]	Strigiformes (13) [dB]	Other Non-Passeriformes (15) [dB]
0.25	~40	~20	~10
0.5	~30	~15	~5
1	~20	~10	~0
2	~15	~5	~0
4	~10	~0	~0
6	~15	~5	~0
10	~30	~15	~5

Hearing

- Orientation
 - Barn Owl can locate prey to within 1° in both horizontal and vertical planes
 - Asymmetrical Ears
 - Left ear = below
 - Right ear = above

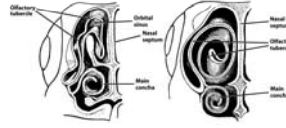


Taste

- Few taste buds
 - 24 in chickens, 62 in quail
 - Compare to 10,000 in humans
 - Provide basic taste information (sweet, salt, sour, bitter), lipid and sugar presence

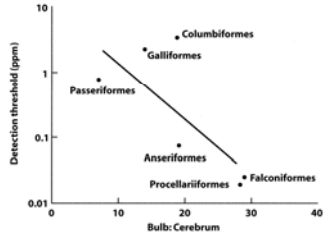
Smell

- Better than once thought
 - Small olfactory bulb
 - Olfactory tubercle on conchae



Smell

- Relative size of olfactory bulb to cerebrum
- Nocturnal birds tend to have better sense of smell




Smell

- Foraging
 - Turkey Vultures
 - Leach's Storm-Petrel
 - Detects scent up to 12 km




Smell

- Nest and Mate Recognition
 - Seabirds can find their own burrows and recognize each other by smell



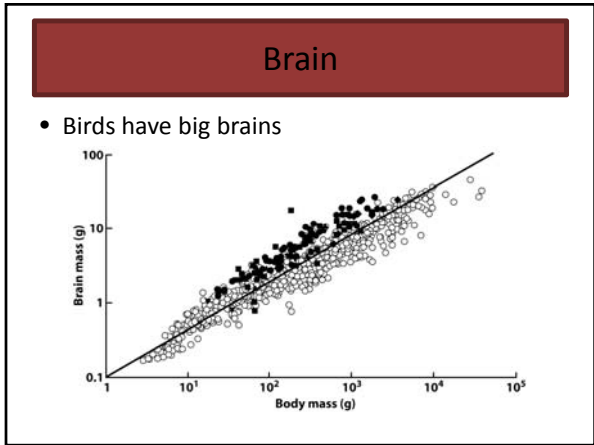
http://alaska.usgs.gov/science/kasatochi/images/birds/gulllet_flock.jpg

Smell

- Courtship
 - Tangerines

Brain

- Birds have big brains
 - 6 to 11 times the size of reptile brains
 - Comparable to mammals
 - 2 to 9% of body mass
 - Parrots, owls, crows, woodpeckers, hornbills have especially large brains



Brain

- Birds have big brains

Forebrain

- Complex behavioral instincts
- Sensory integration
- Learned intelligence

Midbrain

- Regulates vision
- Muscular coordination, balance
- Physiological controls

Brain

- Functional Lateralization
 - Left Hemisphere Dominant
 - Complex integration and learning
 - Suppresses sexual and attack behavior
 - Right Hemisphere
 - Monitors environment
 - Filters stimuli

Brain

- Functional Lateralization
 - Birds may be right or left “handed”
 - Crossbills


Vancouverislandbirds.com

Brain

- Hippocampus
 - Spatial Orientation and Cognitive Memory
 - Damaged hippocampus prevents homing pigeons from learning a map
 - Corvidae, Sittidae, and Paridae cache seeds
 - Large hippocampus
 - If damaged, continue to hide seeds, but can't find them

Brain

- Hippocampus


- Clark's Nutcrackers hide over 30,000 seeds in 2,000 sites; can find them 9 months late

Brain

- Neuron Growth
 - Birds can grow new neurons!
 - Some new synapses are ephemeral
 - Avian brain dynamic
- Important implications for human medicine

Brain

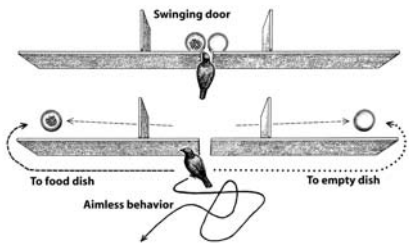
- Sleep
 - Essentially all birds sleep (some vertebrates don't)
 - Three Types
 - Slow-wave Sleep
 - Intermediate Sleep
 - Rapid-eye-movement (REM)

Brain

- Sleep
 - Slow-wave Sleep
 - Unihemispheric
 - One side of the brain sleeps, other side awake
 - Allows vigilance for predators
 - Unihemispheric sleep combines with short periods of REM allowing some birds to sleep while engaged in active flight
 - Birds Dream

Intelligence


- Birds are smart



Cats, rabbits, and chickens do poorly Crows and dogs do well

Intelligence

- Birds are smart
 - Counting
 - Monkeys require 21,000 trials; rats never learn
 - Ravens and parakeets can count to 7



Intelligence


- Birds are smart
 - Conveying Knowledge



http://homepage.ntworld.com/complex_birds/Home.html

Intelligence

- Birds are smart
 - Problem Solving
 - Darwin's finches move stones
 - 27 g finch moved a **378 g** stone



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Intelligence

- Tool Use

