Chapter 51

Animal Behavior

What is behavior?

- Behavior = an action carried out by muscles or glands under the control of the nervous system in response to a stimulus
  - It is a response to external and internal stimuli in an organism's environment or body
  - It can be solitary or social, fixed or variable and is based on physiology
  - It is essential for acquiring nutrients & finding a partner for sexually reproducing.
  - It is used to maintain homeostasis.
    - Ex: Using muscles in chest & throat to produce a mating song
    - Ex: Honeybees huddle to produce and conserve heat in order to maintain homeostasis
- Animal physiology contributions to behavior and behavior influences all of physiology

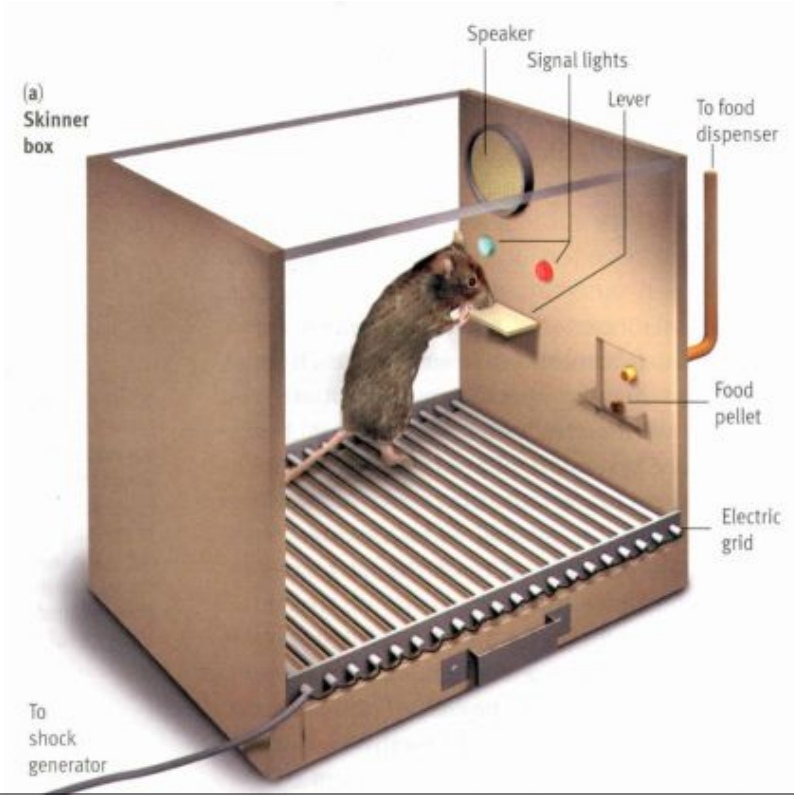
Behavior is critical for survival & reproduction

Why study behavior?

- From an evolutionary perspective…
  - Behavior is just another part of phenotype
    - It is acted upon by natural selection
      - lead to greater fitness?
      - lead to greater survival?
      - lead to greater reproductive success?
        - Selection acting on behavior also affects anatomy since form and appearance underlie behavior

Studying Animal Behavior

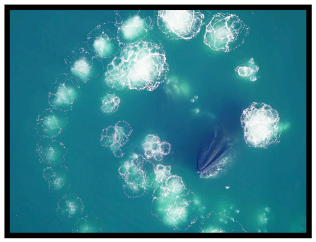
- Scientists rely on both types of science, **discovery** and **hypothesis-based** (experimental) science when studying animal behavior.
  - One involves observations & data analysis
  - The other tries to create testable hypothesis to explain behaviors seen.



Animal Behavior

- **What an animal does as it interacts with its environment and why can be scientifically investigated**

Ex: This observation to the right raises further questions…



Is this behavior learnt or is the whale born knowing how to do this?

BUBBLE NET- HUMPBACK WHALE

A precise, circular net of bubbles blown underwater that may entrap schooling fish or cause them to clump. Associated with the feeding behavior of generally more than one whale.

http://www.whalewatch.com/research/images/behaviors/behavior16.jpg

What causes behavior?

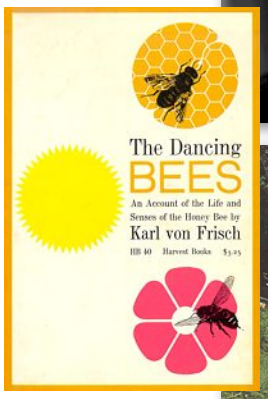
- **Discrete sensory inputs**
  both simple and complex behaviors
  - **An animal's behavior is the sum of its responses to external and internal stimuli.**
  - **Ethology = the scientific study of how animals behave, particularly in their natural environment.**
  - **To understand behavior scientists ask four questions:**
    1. **What stimulus elicits the behavior and what physiological mechanism mediate the response?** ***(proximal causation)***
    2. **How does the animal's experience during growth and development influence the response?** ***(proximal causation)***
    3. **How does the behavior aid survival and reproduction?** ***(distal causation)***
    4. **What is the behavior's evolutionary history?** ***(distal causation)***

Ethology

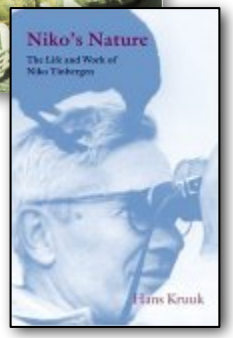
All three shared the Nobel in 1973

Pioneers in the study of animal behavior

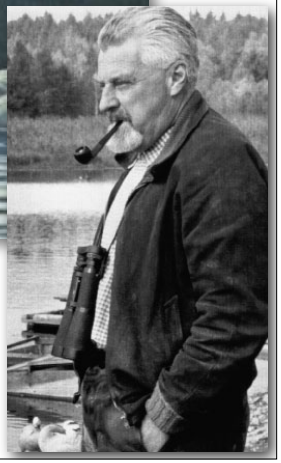
Karl von Frisch



Niko Tinbergen



Konrad Lorenz



The 4 questions on behavior can be grouped into 2 categories - proximate causation & ultimate causation.

We can ask "WHAT" is the behavior?, "HOW" is the behavior performed?, & "WHY" is the behavior performed altogether?

1. **Proximate** causes of behavior
   - What is the immediate stimulus & mechanism of performing the behavior
     - "what" & "how" questions
2. **Ultimate** causes of behavior
   - What's the evolutionary significance of the behavior
   - how does behavior contribute to survival & reproduction
     - adaptive value?
       - "why" questions

male songbird
→ what triggers singing?
→ how does he sing?
→ why does he sing?

→ how does day length influence breeding or the production and response to hormones?
→ why do cranes breed in spring?

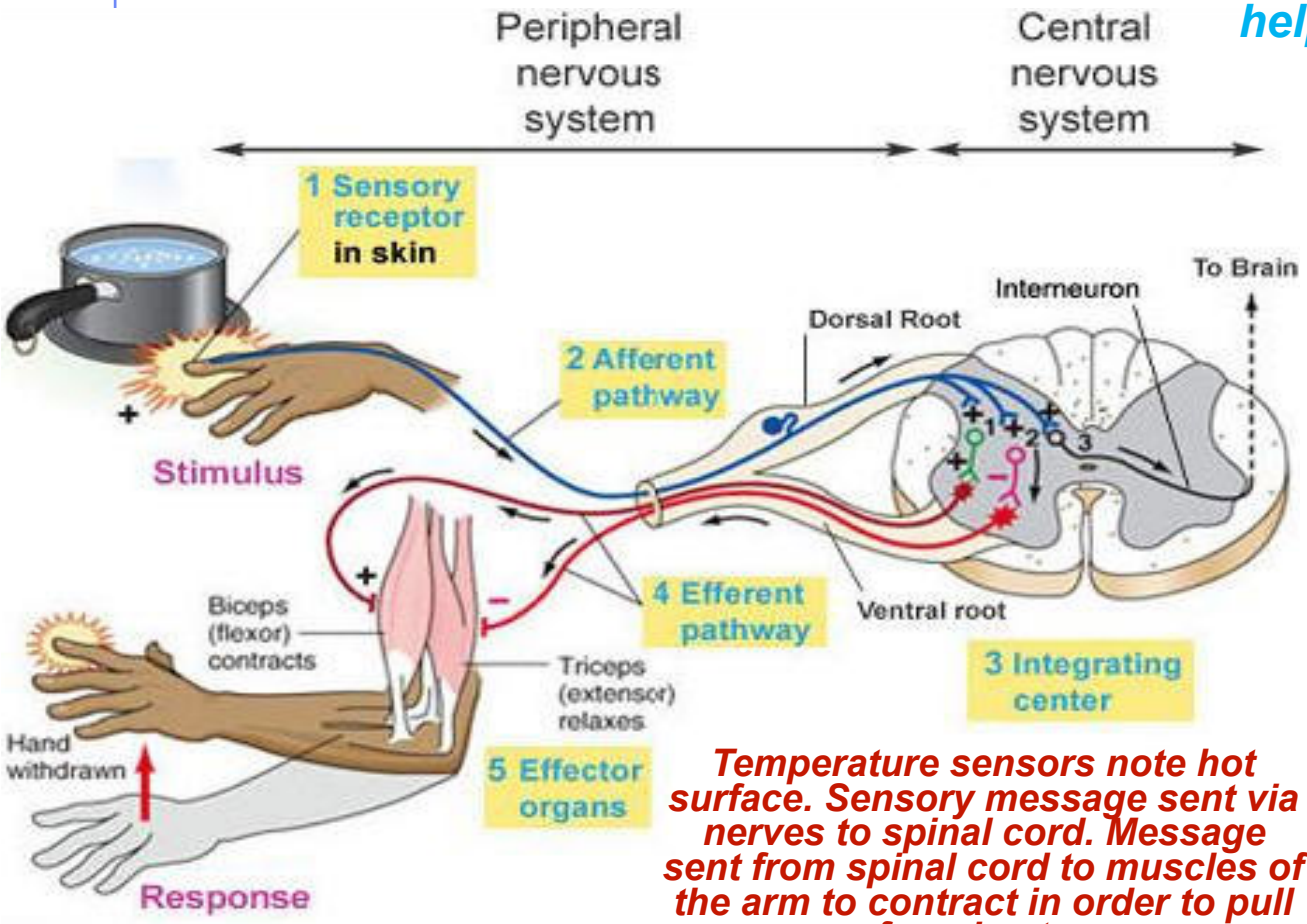
Maybe this leads to greater fitness because parents who breed in spring are more likely to find food for growing offspring in spring & summer who then have a better chance of surviving.

Courtship behavior in cranes
→ what…how… & why questions

You pull your hand away when you burn it on the stove

What are the Immediate Causes?

(What happens in the organisms body to produce the behavior - the biological mechanism)



Temperature sensors note hot surface. Sensory message sent via nerves to spinal cord. Message sent from spinal cord to muscles of the arm to contract in order to pull away from heat source.

Ultimate Causes?

(Why would this behavior have evolved? How does it help the organism survive or reproduce?)

Injury can result in death by predators, infection, starvation… Avoiding injury increases species ability to survive & reproduce.

Musk Oxen arrange in a ring facing out with their young at the center when predator is identified.

Immediate Causes?

Eyes send sensory information to brain, brain interprets events as dangerous, and brain sends impulses to muscles to move into ring formation.

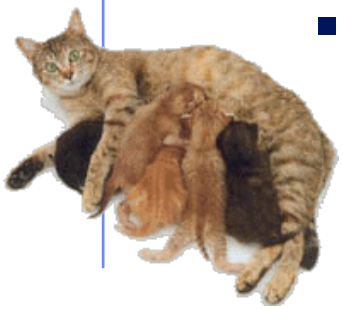
Ultimate Causes?

Ensuring greater survival of offspring, ensures greater success in mating, allowing the species to continue to exist.

http://www.harunyahya.com/books/science/devotion/images_devotion/musk_oxen.jpg

What is behavior?

- **Behavior ranges from innate to learnt**
  - **Innate behavior**
    - **inherited, "instinctive"**
      - **automatic & consistent**
        - **allows animal to do something critical for survival or reproduction correctly from first try**

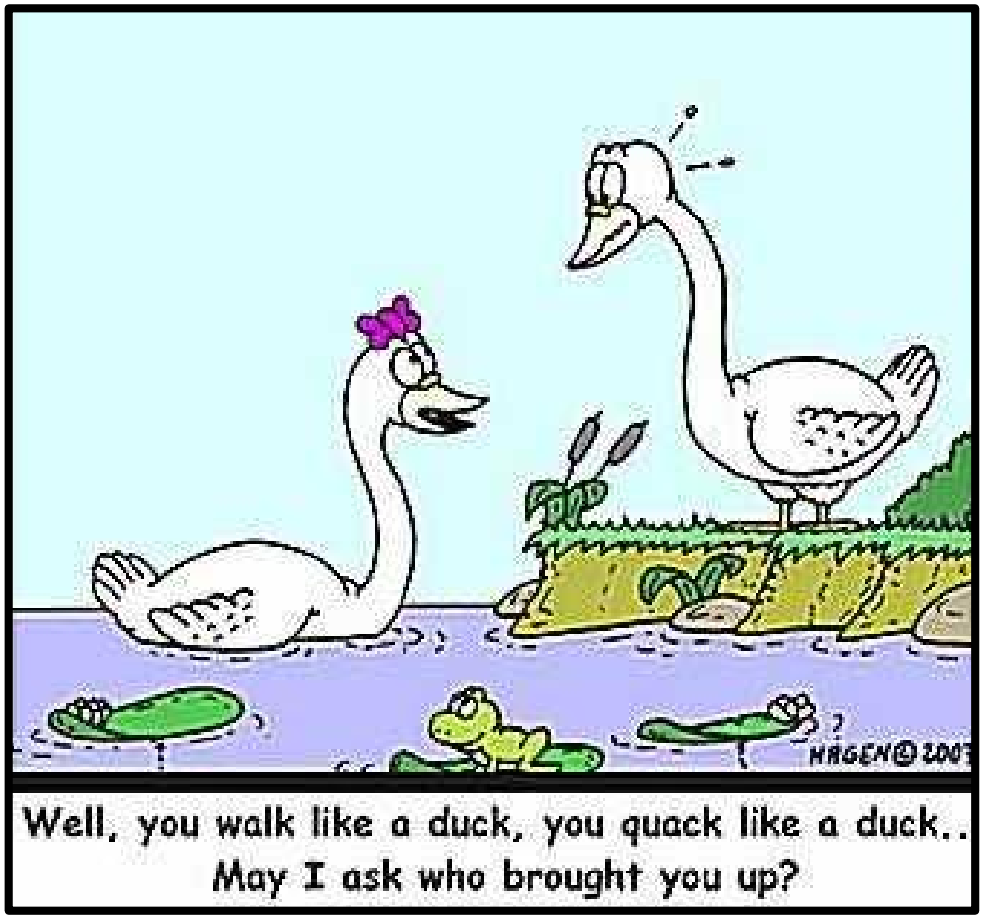


  - **Learned behavior**
    - **ability to learn is inherited, but the behavior itself develops during animal's lifetime**
      - **variable & flexible**
        - **changes and perfected with experience & allows animal to learn new behaviors for changing/different environments and situations**

The Nature versus Nurture debate?

Is behavior due either to genes (nature) or to environmental influences (nurture)?

To a certain extent, all animal behaviors depend on a combination of genes and environment.



http://www.cartoonstock.com/newscartoons/cartoonists/cga/lowres/cgan1299l.jpg

Innate Behaviors - determined by genes

- A behavior that is performed correctly by all individuals of a species, even if they have no previous experience with the behavior, is called an Innate Behavior
  - This is a developmentally fixed behavior
    - Ex: Cuckoo & Cowbird nest parasitism

- ***NOTE:*** *Often even highly programmed behavior, however, is influenced by the environment and so it not solely determined by genes.*

Innate Behaviors in European Cuckoos

- Cuckoos lay their eggs only in the nests of other species
  - A cuckoo egg usually closely mimics the eggs of the host

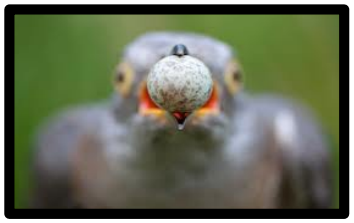
- After hatching, the young Cuckoo, using a scoop-like depression on its back, instinctively shoves over the edge of the nest any solid object (the other eggs)
  - The foster parents are now free to devote all of their care to the young cuckoo alone.

Innate Behaviors in Cowbirds

- Example of innate behavior is also seen in the obligate nest parasites, the Cowbirds
  - Cowbird moms lay their eggs in nests of warblers
    - The chick opening its mouth to receive food is an innate behavior.
    - Adult warbler also exhibit innate behavior by feeding the loudest open-mouthed chick in the nest.
      - The "mother" feeds the cowbird and ignores her young who starve.

Innate Behaviors in Cowbirds

- What may evolve in the host bird species as a response the genetic foundation is laid for its development?
  - Cowbirds place powerful selection pressure on a host bird species to learn to recognize and reject cowbird eggs.
    - Research has shown experimentally that some North American species have, indeed, learned (evolved) to do this.
      - Behaviorist Stephen Rothstein of the U.C. Santa Barbara found that acceptors include many warblers, vireos, phoebes, and song sparrows, while robins, catbirds, blue jays, and brown thrashers are rejectors.



Innate Behaviors - *egg rolling in geese*

If a goose bumps one of her eggs out of her nest, she uses her beak to retrieve it in the same way every time.

Even if the egg is pulled away, the goose still continues the motion as though the egg is still there until the series of actions are completed!

http://io.uwinnipeg.ca/~simmons/16cm05/1116/eggRetrieval.jpg

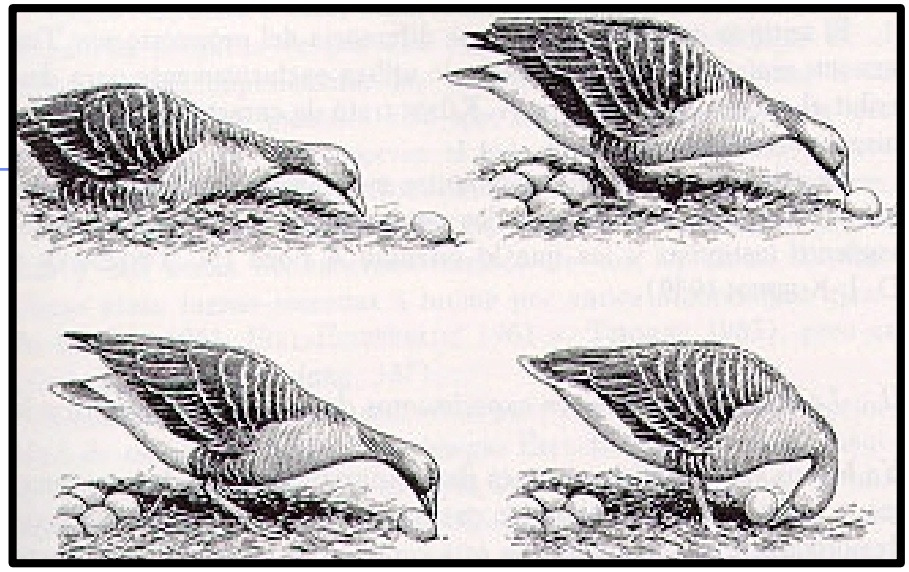
http://www.bemabegeen.com/images/uploads/CanadianGoose.jpg

Type of Innate Behavior Directly Linked to a Simple, Well-Defined Stimulus =

FIXED ACTION PATTERN

(Examples: Tinbergen's Three-Spined Stickleback fish & Gray Goose Egg Retrieval Behavior)

Innate Behaviors IS affected by environment



Fixed Action Pattern (FAP)
= an innate behavior that occurs as an unchangeable sequence of unlearned actions that, once initiated, is carried out to completion.

FAP's are triggered by a simple, specific environmental stimuli called a SIGN STIMULUS.

Ultimate cause for FAP Evolution = Allows an animal to perform a task correctly the first time without learning the behavior.

Support for Hypothesis = FAP's often involve activities that are critical to survival and reproductive success.

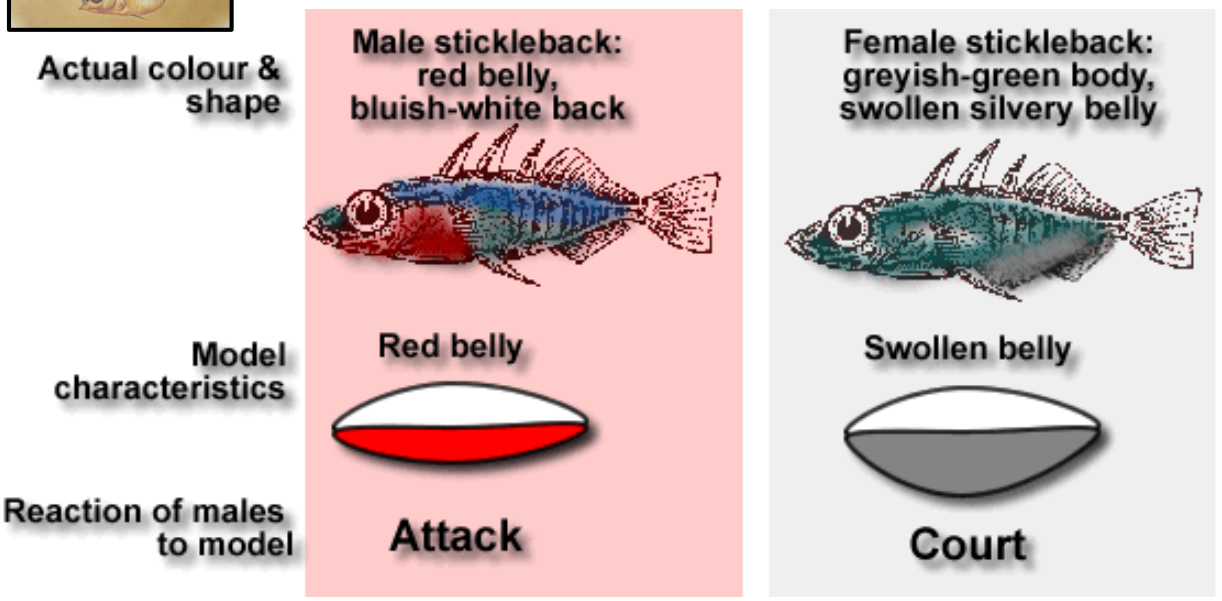
Innate behaviors - FAP

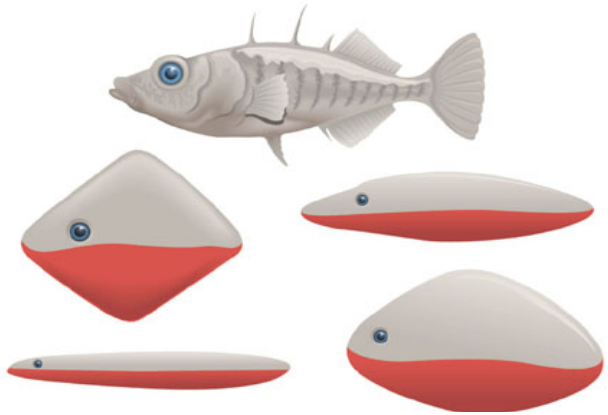
male sticklebacks exhibit aggressive territoriality

- **During mating season, a male stickleback fish attacks other males, that invade its nesting territory.**
  - **sign stimulus = external cue that triggers FAP (the red belly of males - females lack red belly)**
    - **the releaser that triggers aggressive behavior, an FAP!**

PROXIMATE CAUSE: The red belly of the intruding male acts as a sign stimulus that releases aggression in a male stickleback.

ULTIMATE CAUSE: By chasing away other male sticklebacks, a male decreases the chance that eggs laid in his nesting territory will be fertilized by another male.

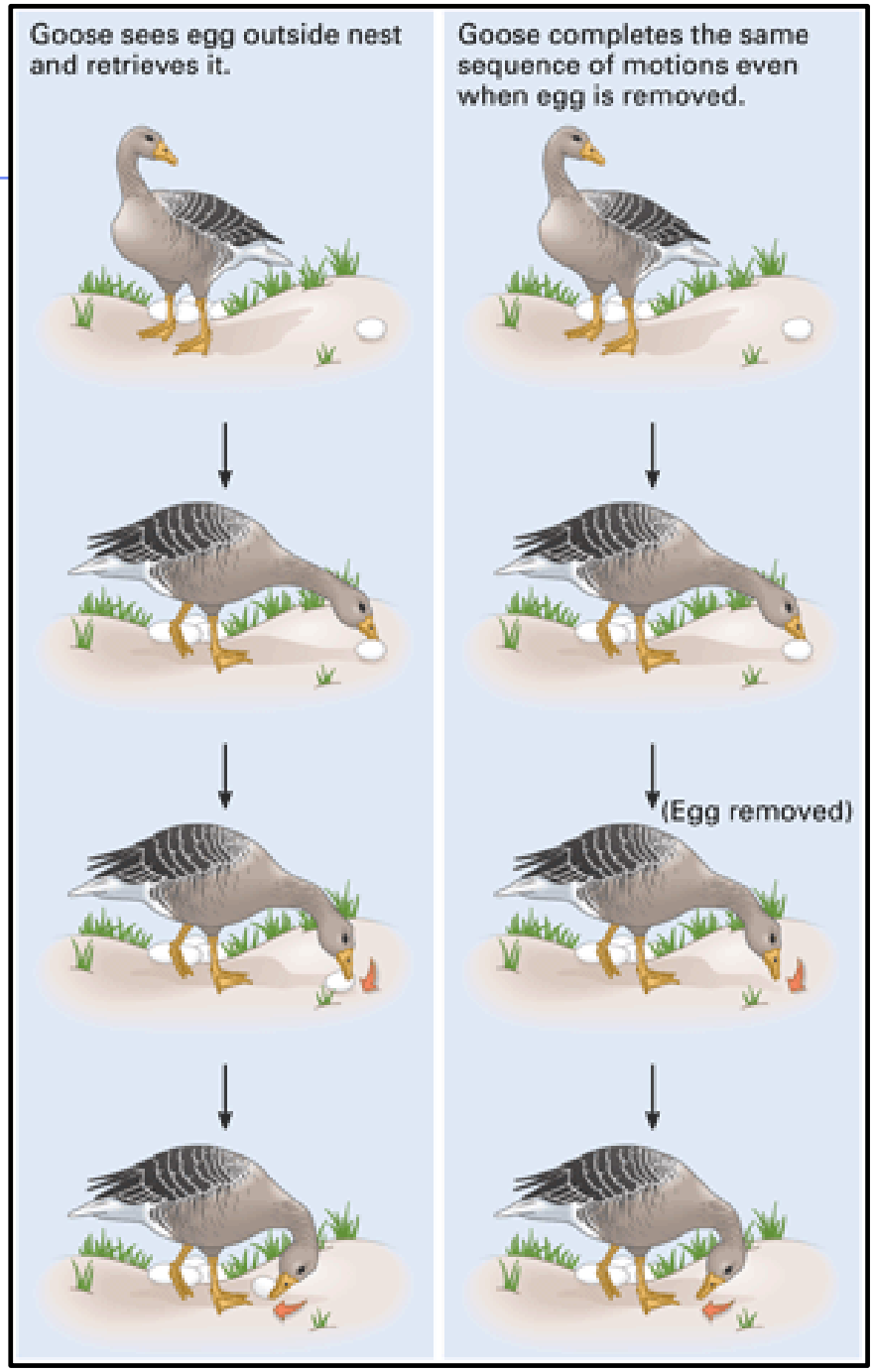




Realistic model w/out red = no aggressive response in males

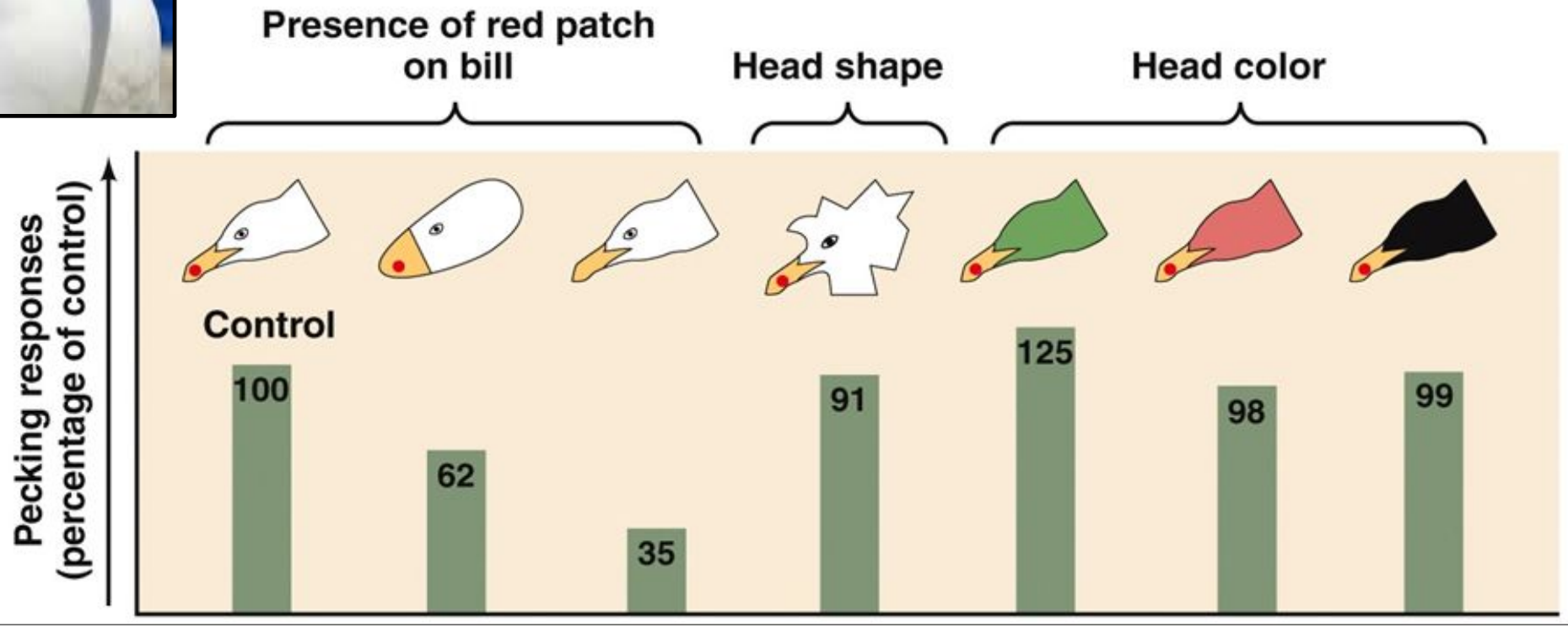
A red belly stimulus = gets attacked

The goose completes a certain set sequence of movements when an egg is spotted outside the nest, even if the egg is removed once it has served as the initiating sign stimulus.



Tinbergen studied FAP's in Stickleback Fish & Gulls.

- Gull chicks beg in response to an appropriate colored dot on the beak of the parent.
  - The dot is the sign stimulus.
  - The begging behavior is a fixed action pattern.



Fixed Action Patterns (FAP)

1. Before taking provisions into the nest, the sphex wasp first inspects the nest, leaving the paralyzed prey outside.
2. If during inspection, an experimenter removes the prey, the sphex emerges from the nest ready to drag in the prey but finds the prey missing.
3. The sphex quickly locates the moved prey, but now its behavioral "program" has been reset.
4. After dragging the prey back, once again the sphex is compelled to inspect the nest, so the prey is again dropped and left outside during another stereotypical inspection of the nest.

This iteration can be repeated again and again, the sphex never able to escape from its genetically-programmed sequence of behaviors.

Fixed Action Patterns (FAP) or “universals” in humans?

Examples include smiling and the "eyebrow-flash”

Himba woman from Namibia (SW-Africa) shows a rapid brow raising (between the second and third still images) which coincides with raising her eyelids.

Despite different cultures, humans all exhibit this behavior.

Do humans exhibit Fixed Action Patterns?

The “eyebrow-flash”

Fixed Action Patterns (FAP) or “universals” in humans?

Many instinctive (innate) movements generally manifest themselves soon after birth.

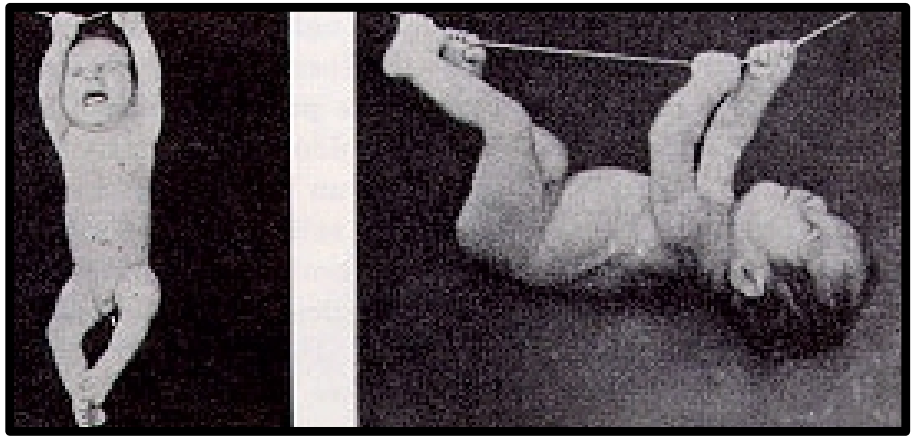
They are called **behavioral reflexes**.

Ex: Prehensive reflex of the hand of newborns, who firmly hold any object.

Quantitative measures showed that infants apply more strength if they touch hair.

This FAP appeared by evolution among primates, so that the infant can hold to the mother's hair and not fall off when she moves briskly.

Given a rope, newborns hold firmly and remain suspended by themselves.



Human babies have an **innate dive reflex**

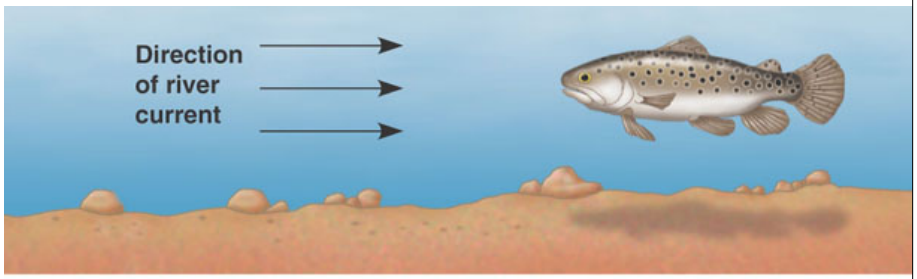
Water on the face is the **sign stimulus**

Closing the mouth, holding breath, and kicking constitute the **fixed action pattern**

Innate: Directed unlearned, instinctual movements triggered by environmental cues

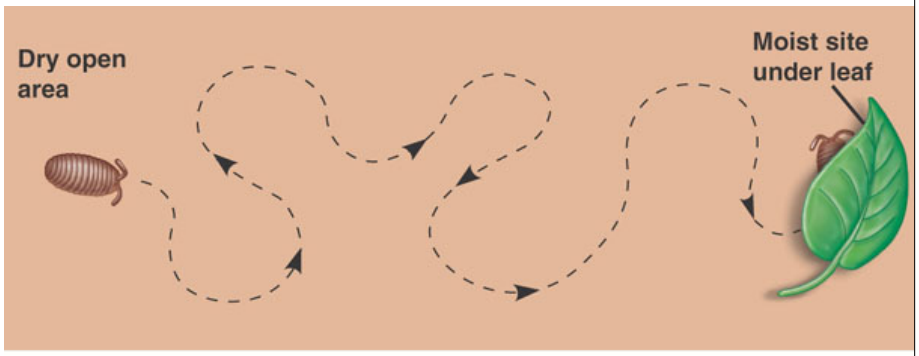
- **Taxis**
  - change in direction
  - automatic movement toward (positive taxis) or away from (negative taxis) a stimulus
    - Phototaxis
    - Chemotaxis
- **Kinesis**
  - change in rate of movement in response to a stimulus

Trout exhibit positive rheotaxis (from the Greek rheos, current). They automatically swim or orient themselves in an upstream direction (toward the current). This taxis keeps the fish from being swept away and keeps them facing the direction from which food will come.



(b) Positive rheotaxis keeps trout facing into the current, the direction from which most food comes.

Though sow bugs do not move toward or away from specific conditions, they become more active in dry conditions, increasing the chance that they will leave a dry area and encounter a moist area. And since they become less active in humid areas, they tend to stay there once they encounter it.



(a) Kinesis increases the chance that a sow bug will encounter and stay in a moist environment.

Complex Innate behaviors

- **Migration** = *a regular, long-distance change in location*
  - Animals, birds, fish, and insects, pass through environments they have never encountered
    - Bird migration, for example, is a behavior that is largely under genetic control.
      - "migratory restlessness" seen in birds bred & raised in captivity
        - navigate by sun, stars, Earth magnetic fields

Monarch migration

Sandpiper

Bobolink

ancient fly-ways

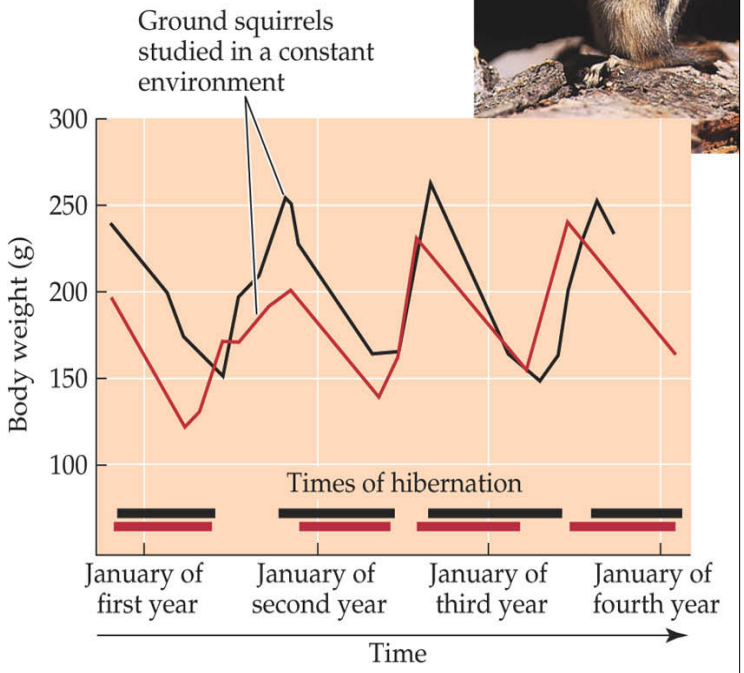
Golden plover

Complex Innate behaviors

- **How do animals migrate?**
  - **This question is a search for Proximal or Distal Cause?**
    - Animals may track position relative to the sun, but the sun's position relative to Earth changes throughout the day.
      - Some animals may adjust to sun's movement with their circadian clock, an internal 24-hour cycle.
    - Nocturnal animals may use the North Star, having a constant position in the sky, but clouds can obstruct view.
    - Animals may be able to sense their position relative to the Earth's magnetic field in order to navigate without solar or celestial cues.

- **Why do animals migrate?**
  - **This question is a search for Proximal or Distal Cause?**
    - To get to food & water during seasons when there is scarcity
    - To survive and protect their young offspring from harsh weather conditions.
    - To get away from predators.
    - To find a safe place to breed.

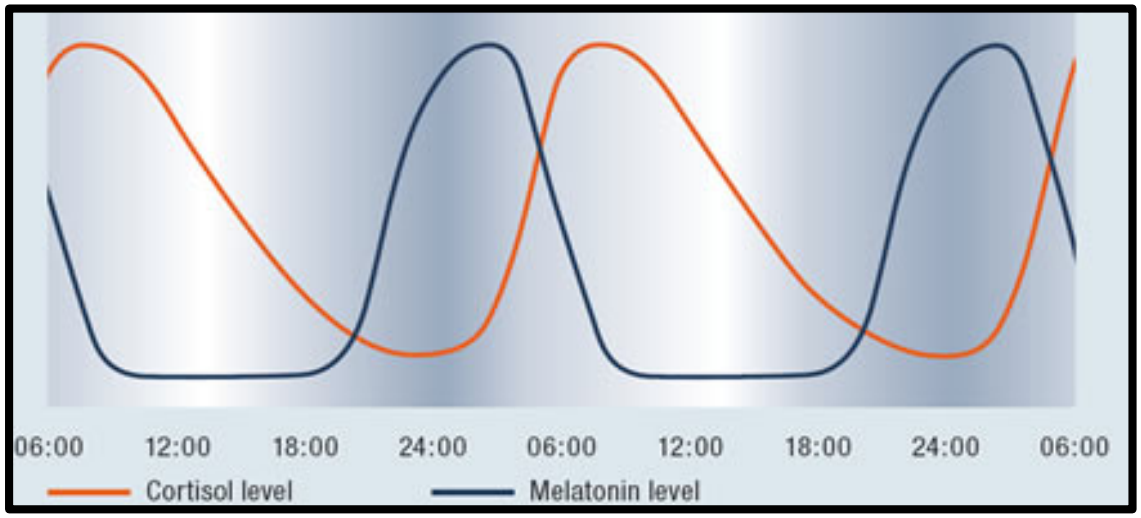
Circadian & Biological Rhythm

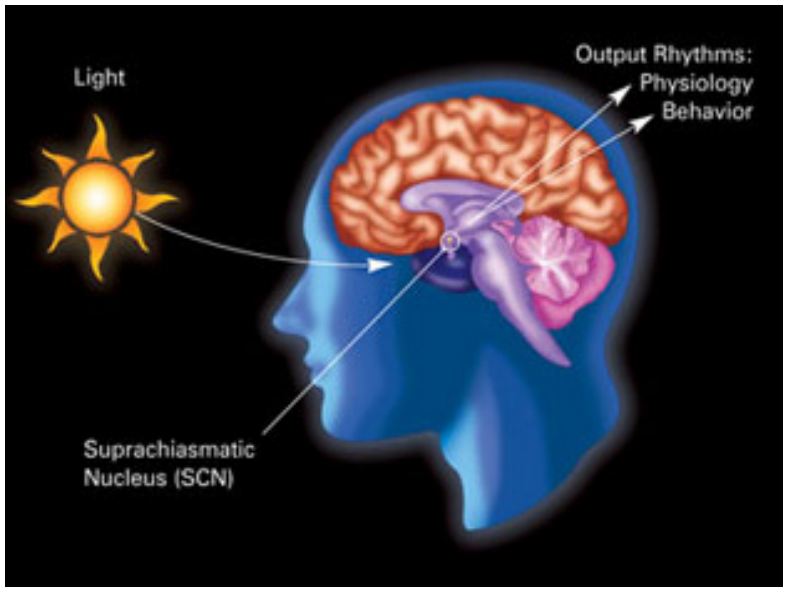


- **Biological Rhythms have shorter longer cycles or periods such reproduction or migration**
  - **Circannual rhythms are rhythms linked to of seasons**
    - **Proximal Cause = In some birds, the length of night and daylight triggers migratory behavior**
    - **Ultimate Cause = migration and reproduction seemingly correlated with food availability.**
    - **Proximal cause = male Fiddler crabs court females in coordination w. lunar cycles (new & full moons) not just day length.**
    - **Ultimate Cause = Timing behavior to lunar cycle links reproduction to the times of greatest tidal movements**
      - **Tides disperse larvae to deeper waters where they can develop safely before returning to tidal flats.**

Circadian & Biological Rhythm

- **Another Example of Biological Rhythm is the Circadian Rhythm**
  - **Circadian Rhythms are innate rhythms with a 24 hour cycle of rest and activity with far-reaching effects on behavior**
    - **Controlled by "BIOLOGICAL CLOCK", nerve cells in hypothalamus, but IS influenced by the environment.**





Rhythms of Behavior are determined by genes but affected by the environment

- **Animals can synchronize behaviors with their environment.**
  - The circadian rhythm is normally synchronized with the light and dark cycles of the environment
    - Ex: Humans adjust to a change in light/dark patterns but initially may feel "jet lag" upon changing time zones

- **Animal show RHYTHMIC BEHAVIOR PATTERNS synchronized with RHYTHMIC ENVIRONMENTAL CHANGES.**
  - Can be seasonal (duck migrations) or daily (bats active at night).

Circadian Rhythm Study

Flying squirrels that are active at night and sleep from dawn to dusk.

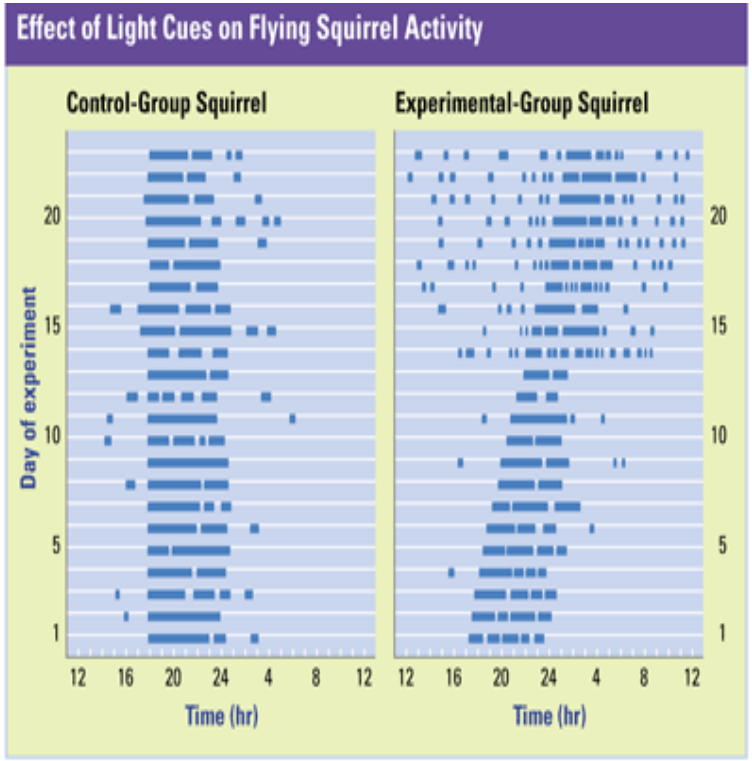
Study: Kept flying squirrels in cage with running wheel. Traced activity of two different light conditions for 23 days.

Control-Group: Squirrels kept in 12 hours of light and 12 hours of dark

Experimental-Group: Squirrels keeps in darkness

Circadian Rhythm

- **Control Squirrels:** Active same time each day.
- **Experimental Squirrels:** Activity period shifted by 21 minutes later each day (almost 8 hour shift over 23 days)
  - When put back in 12 hours of light and 12 of dark, the squirrel activity cycle matched the control squirrels after a few days.
- Even without environmental cues the squirrel kept a daily rhythm of 24 hours and 21 minutes.
- But the Environment influences to help keep the animal on rhythm long term



Environment interacts with genetics to keep the animal coordinated with its external world.

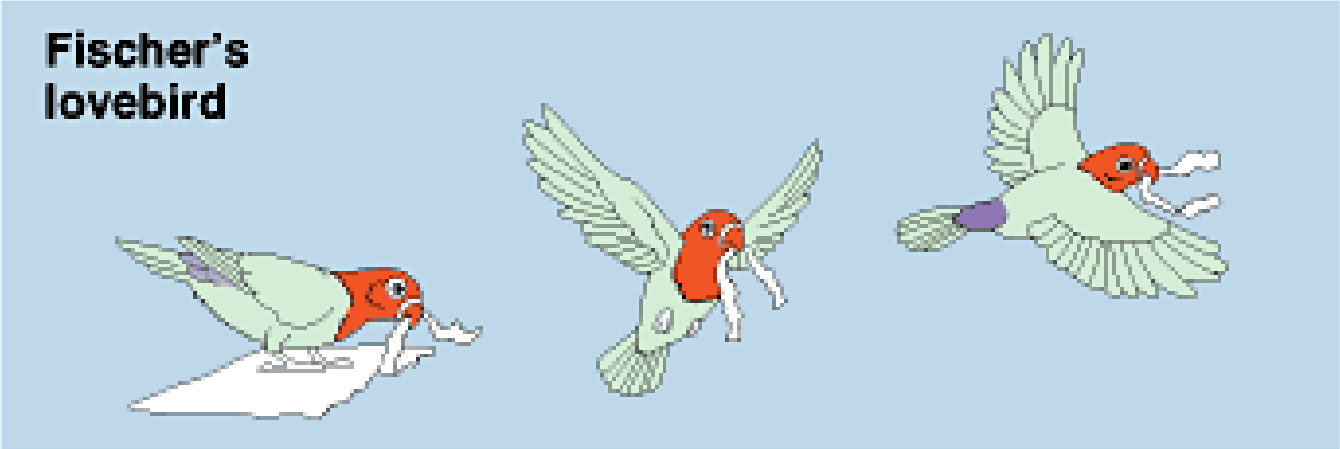
Case Study: Genes interacting with Environment

Experiment to analyze the role of inheritance and experience in forming behavior.

Does the Love Bird know how to behave because of its genes or learning?

Fischer love bird cuts long strips and carries one at a time back to its nest

❶ Nests made with long strips— no tucking behavior



Case Study: Genes interacting with Environment

Peach-faced love bird cuts short strips and carries many back, tucking them into his feathers.

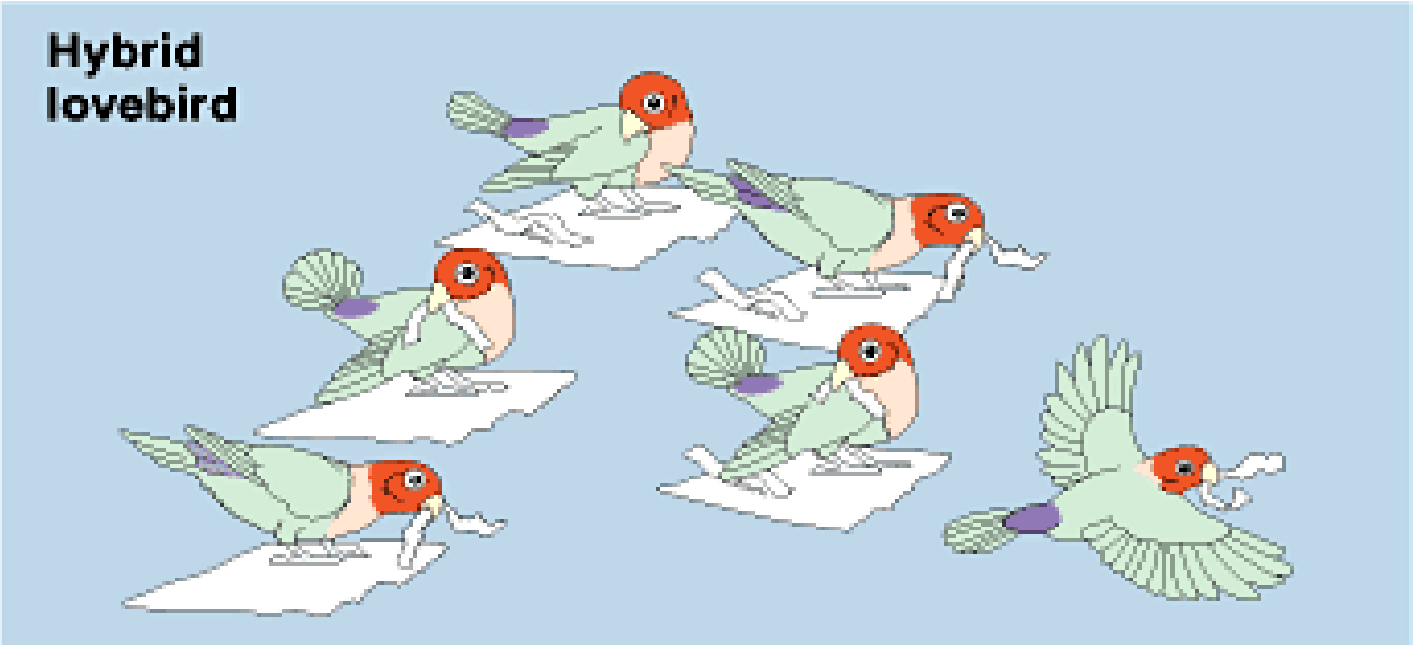
❷ Nests made with short strips—tucking behavior

Case Study: Genes interacting with Environment

Hybrid offspring: First tries to tuck in medium strips without letting go of the paper. Of course this is ineffective.

When that fails, they learn from experience to carry strips.

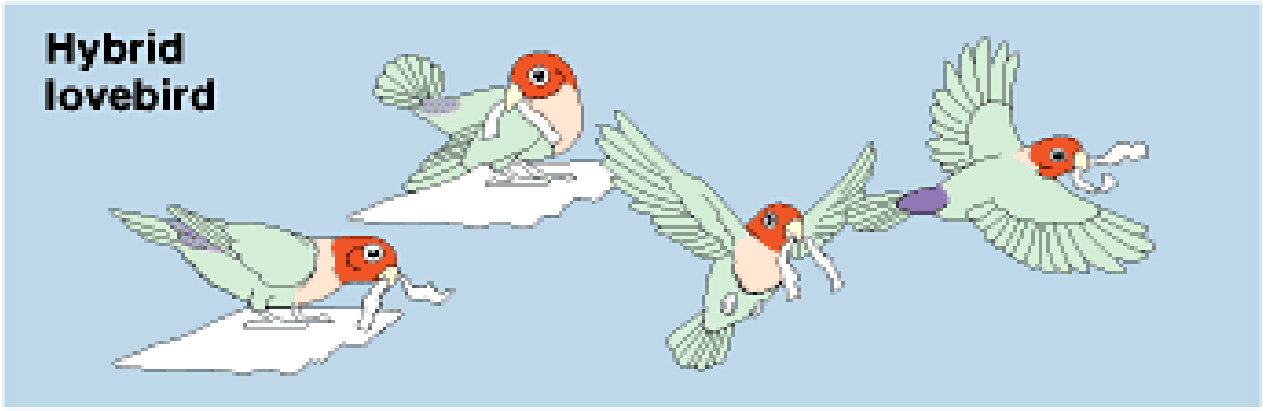
❸ Hybrid nests made with intermediate-length strips—in first mating season, unsuccessful tucking behavior



Case Study: Genes interacting with Environment

Hybrid offspring: **Learns to carry strip in their beak but still act out tucking sequence by turning head back before flying away.**

❹ In later seasons, only head-turning behavior



Behavior may be inherited (innate), but love birds showed that learning also plays a role in shaping behavior.

Learning = the modification of behavior based on specific experience!