



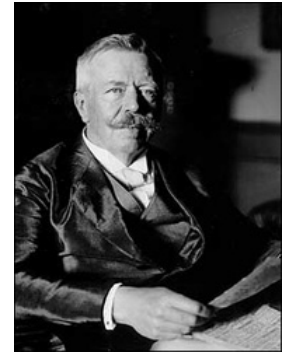
# Introduction to Neuroscience: Behavioral Neuroscience

## Lecture 1: Introduction to Animal Behavior

Tali Kimchi  
Department of Neurobiology  
[Tali.kimchi@weizmann.ac.il](mailto:Tali.kimchi@weizmann.ac.il)



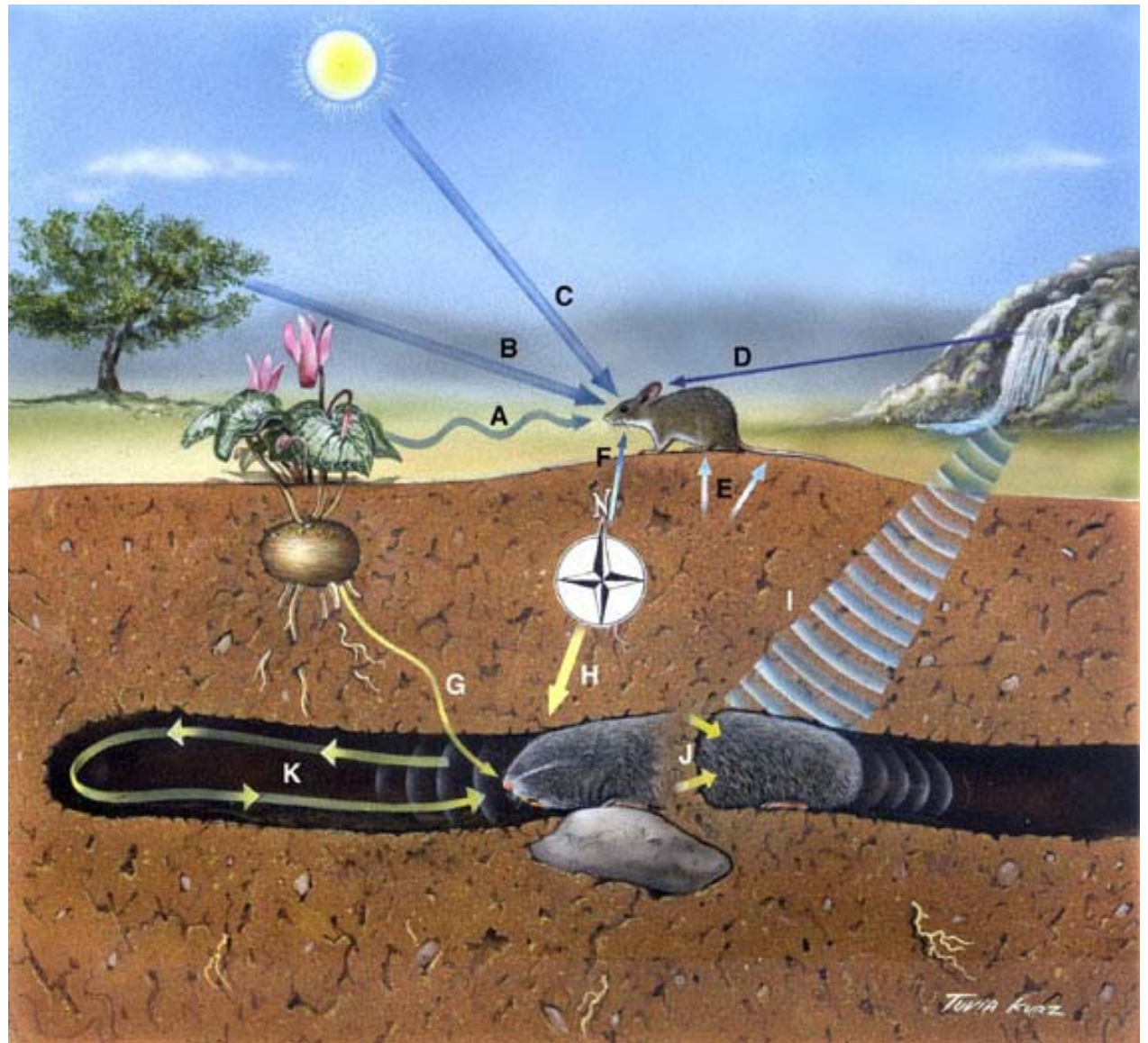
# Jakob von Uexküll (1864-1944)



**"Umwelt"** is the organism's model of the world: the perceived things in the world, the signals emitted by both the subject and things, and the actions that are performed by each species.

- Every species has its own unique **Umwelt** which includes the potentially most relevant information for the individual behavioral repertoires.
- This information is perceived by a set of sensory channels that are specially adapted to the species' survival needs and its niche (biotic and abiotic components).





## Perception of sensory stimuli

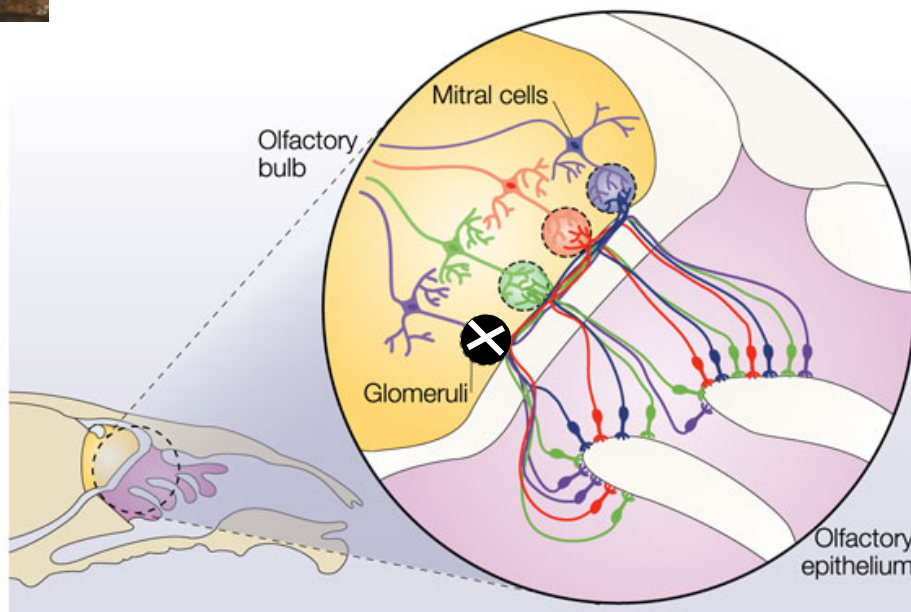


Processing &  
integration of sensory  
information



## Species-specific behavioral repertoires

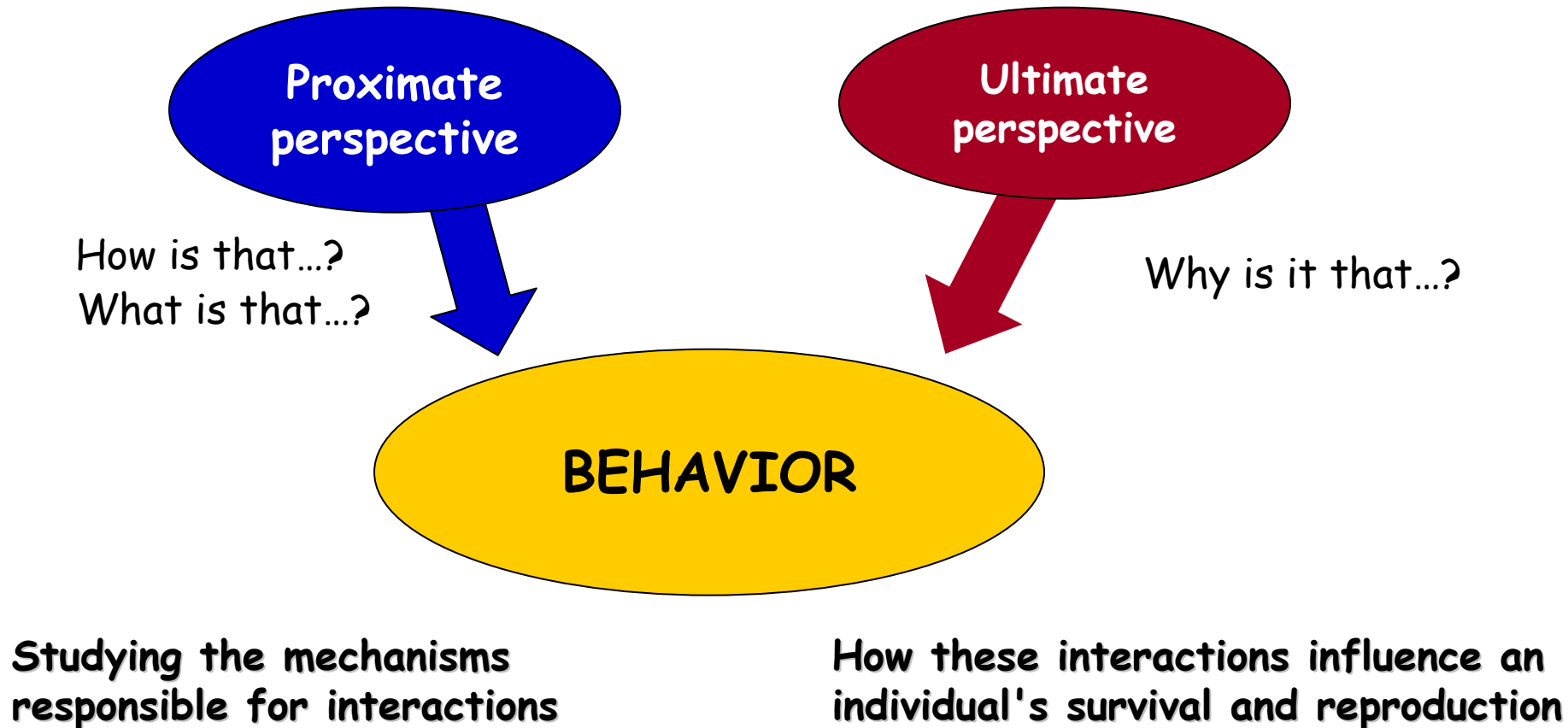






# What is Animal Behavior ?

The study of *how* and *why* animals interact with each other (both within and among species) and their environment.



# History of the study of animal behavior

Paleolithic cave art from ~40,000 years ago provide indirect evidence that primitive humans observed the behavior of animals (e.g. herding animals in groups and aggressive behavior).

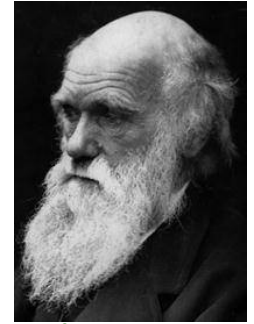


Cave painting, Lascaux, France, 15,000 to 10,000 B.C.



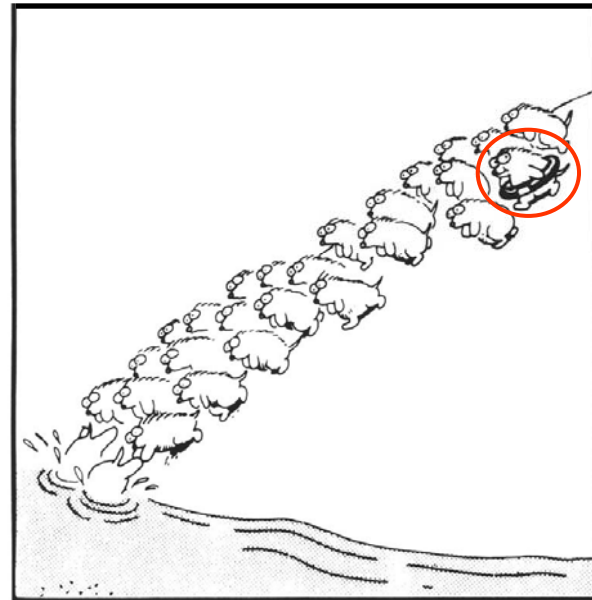


# Darwin's theory of natural selection of behavior

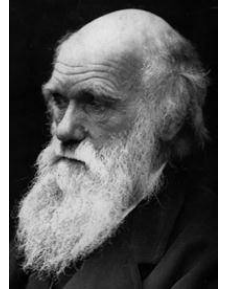


Charles Darwin  
(1809-1882)

1. Variations also exist in behavioral traits.
2. Some of these behavioral variations are heritable.
3. Certain behavioral variations make individuals better adapted to their environment.
4. These individuals have the chance to survive longer and leave more offspring than those with less successful behavioral traits.



# Sexual Selection of behavior



Darwin realized that some (behavioral) traits directly relate to mate acquisition and mate choice.

He termed this evolutionary process "**sexual selection**".

**Sexual Selection** "...depends on the success of certain individuals over others of the same sex, in relation to propagation of the species..."

Charles Darwin 1871

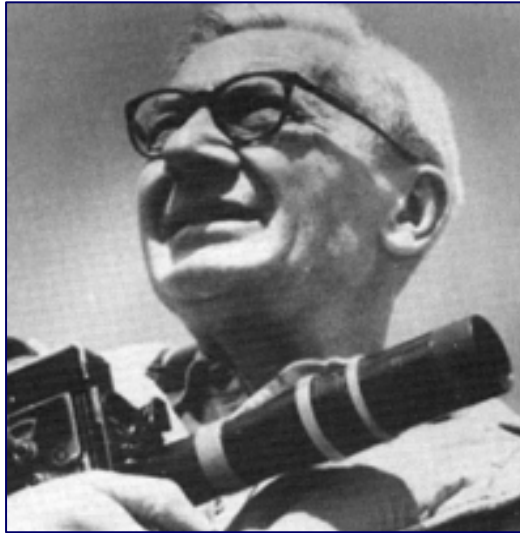
---

**Example: Sexual selection of behavior**  
**The Lyrebird courtship behavior**

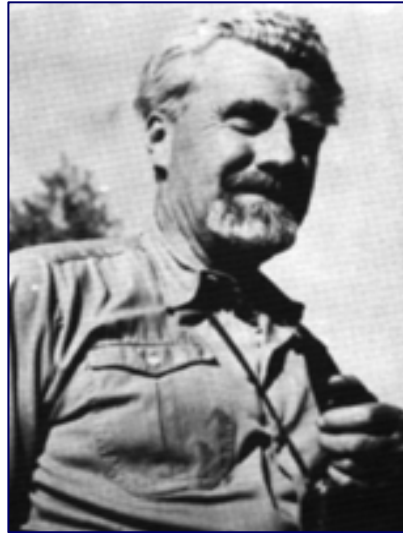




## Founders of animal behavior study in the natural habitats (Ethologist)



**Niko Tinbergen**  
(1907-1988)



**Konrad Lorenz**  
(1903-1989)

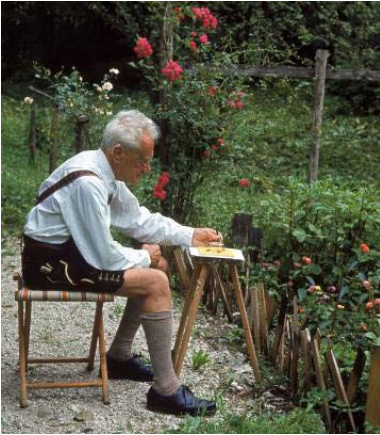


**Karl von Frisch**  
(1886-1982)



**The Nobel Prize in Physiology or Medicine 1973**

"for their discoveries concerning organization and elicitation of individual and social behavior patterns"



## Karl von Frisch



- Pioneered studies in bee communication and foraging.
- Demonstrated that honey bees use a dance language to communicate the location of food resources to other bees.
- The waggle dance uses for communicate the position of a distance food source.
- This dance communicates both the distance and direction using the sun, the hive, and the food source as reference points.

## Honey bee waggle dance

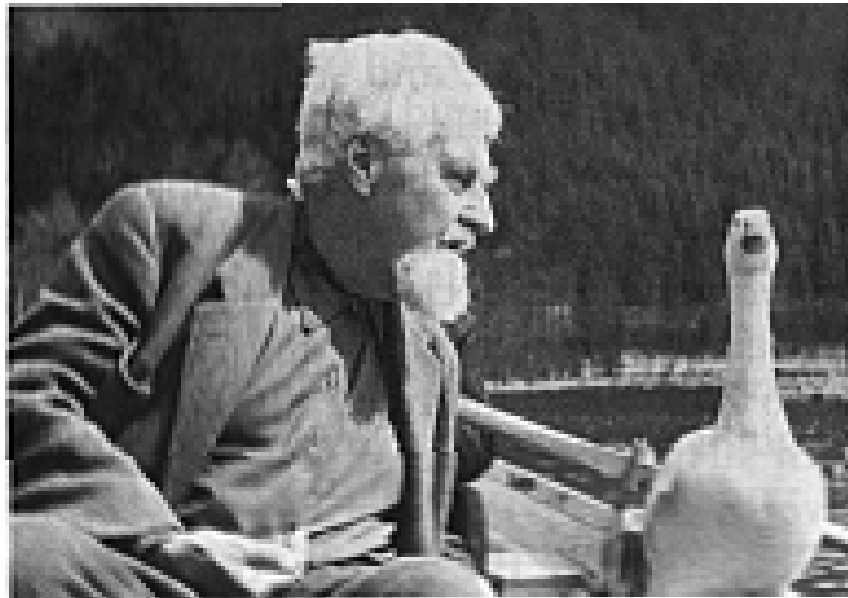




## Konrad Lorenz

**"It takes a very long period of observing to become really familiar with an animal and to attain a deeper understanding of its behaviour; and without love for the animal itself, no observer, however patient, could ever look at it long enough to make valuable observations on its behaviour."**

Konrad Z. Lorenz,  
1960



## Imprinting

- Early recognition of the same group (morphology and behavioral pattern).
- Include both learning & innate components, and generally irreversible.
- Has a sensitive period (i.e. acquired during a limited critical period right after birth).





## Gosling imprinting



**Experiment:** A clutch of goose eggs was divided between the mother goose and an incubator (treated by Lorentz).

**Results:** Goslings reared by the mother behaved normally and mated with other geese.

-Goslings that spent their first hours of life with Lorenz preferred humans for the rest of their lives and even tried to mate with humans.

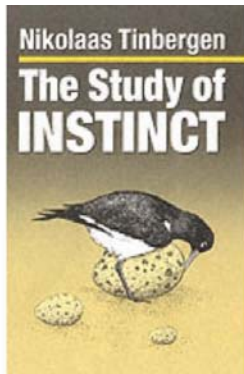
**Conclusions:** Greylags goose have no innate sense of "mother" or "gooseness". They identify with and respond to the first object with certain characteristics they encounter. *The ability or tendency to respond is innate.*

---



# Konrad Lorenz - Gosling imprinting





# Niko Tinbergen



Nikolaas Tinbergen (left),  
Konrad Lorenz (right)

## Fixed Action Pattern (FAP) and Instinct behavior:

- In response to an external sign stimulus (a releaser) the organisms will initiate a fixed (unchangeable) responses which once begun must be carried to completion.
- FAP is innate (instinct) behaviour and highly stereotypically performed.
- In some cases, aspects of the FAP need to be learned (trained) in order to master the behavioral repertoire.

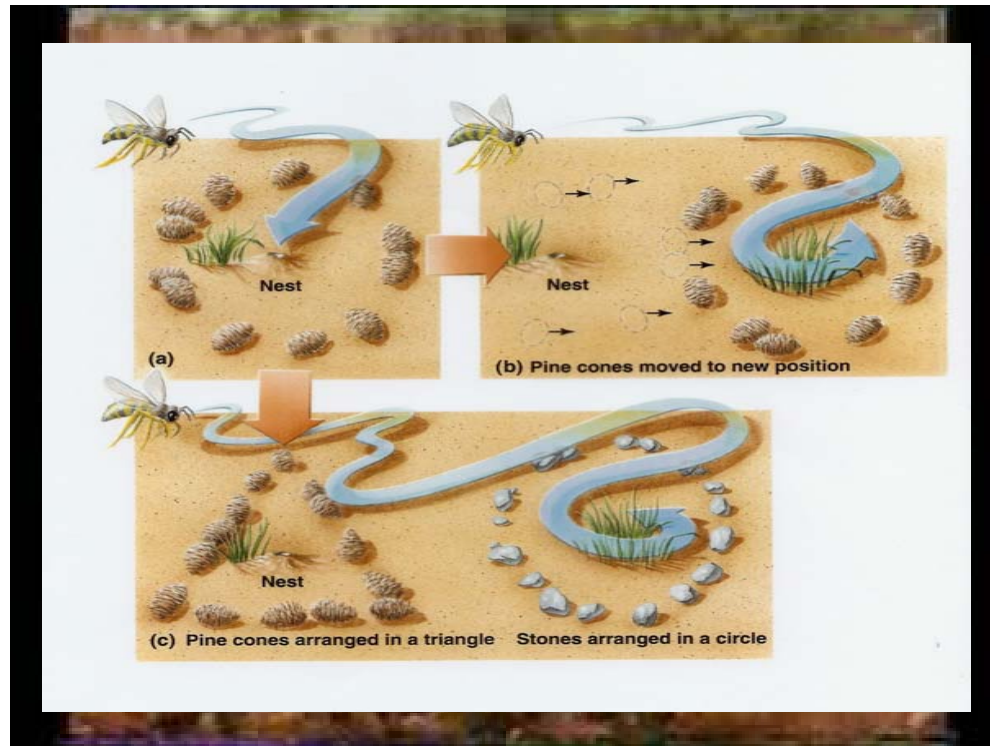
## Nest finding behavior in wasp

How does the wasp find its way back to the nest after returning from a hunting trip?



- Tinbergen noticed that a wasp circles its nest in exactly the same way each time it flew away to hunt.
- He suggested that this fixed action pattern is used to gather visual cues that will be used later to locate the position of its nest.

# Tinbergen's Experiment: fixed action pattern in wasp nest finding behavior





# Fixed Action Patterns: Egg-rolling behavior of the greylag goose



FIG. 69. Grey lag goose retrieving egg. After Lorenz and Tinbergen, 1938.



FIG. 70. Grey lag goose attempting to retrieve giant egg. After Lorenz and Tinbergen, 1938.



- The goose will roll an egg that is outside the nest back into the nest in the same manner every time.
- The goose will do this with any round object placed outside the nest.
- Each time this action pattern is initiated, it is carried through to completion.

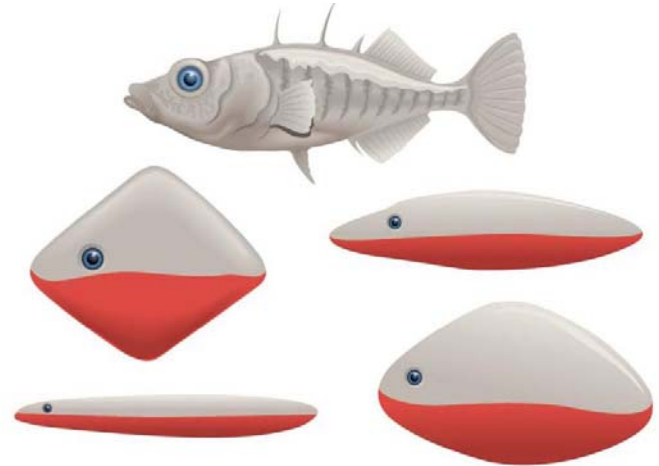


## FAP social behavior in three-spined stickleback (Key visual sign stimulus releasing)



## Fixed action pattern in three-spined stickleback

- Will attack as long as red spot present on the ventral body part.

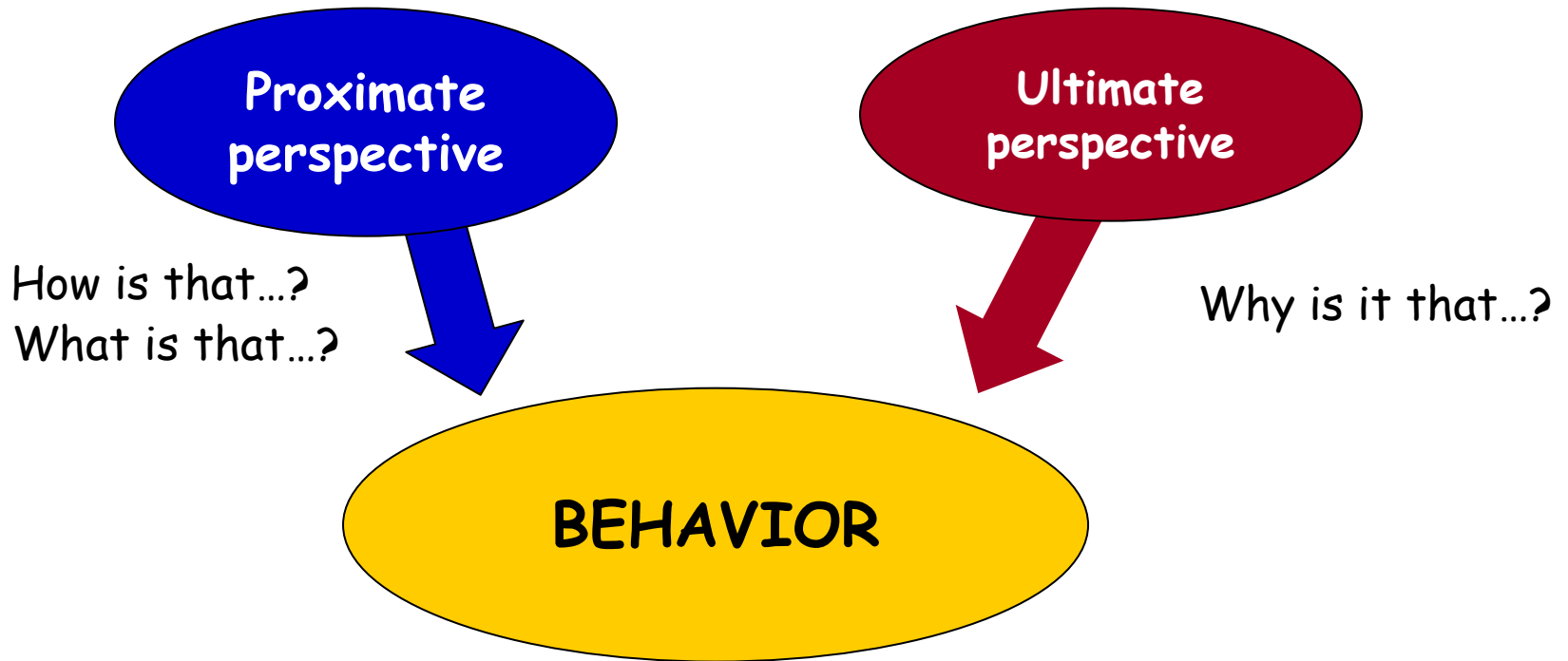


- Will court if white swollen belly (i.e. a pregnant female)









**Studying the mechanisms  
responsible for interactions**

**How these interactions influence an  
individual's survival and reproduction**

## Proximate and ultimate perspectives on aggressive behavior by male sticklebacks

**BEHAVIOR:** A male stickleback fish attacks other male sticklebacks that invade its nesting territory.

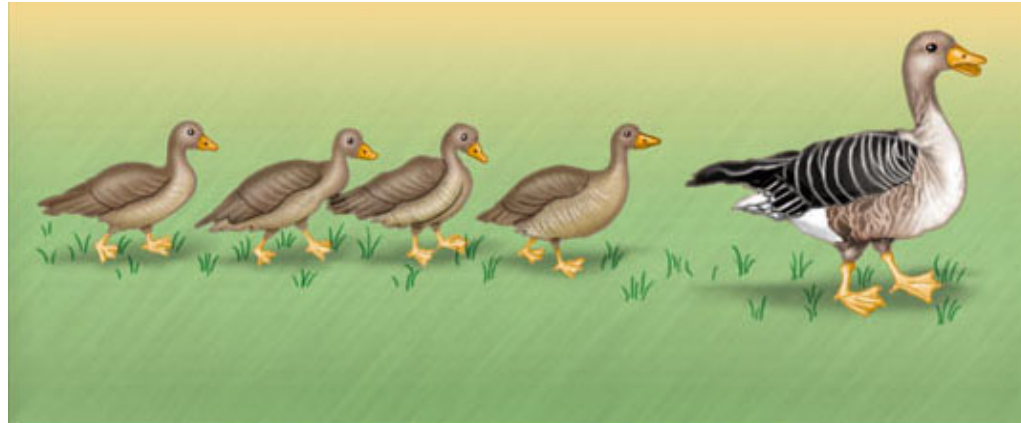


**PROXIMATE CAUSE:** The red belly of the intruding male acts as a sign stimulus that releases aggression in a male stickleback.

**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.

## Proximate and ultimate perspectives on imprinting in graylag geese

**BEHAVIOR:** Young geese follow and imprint on their mother.

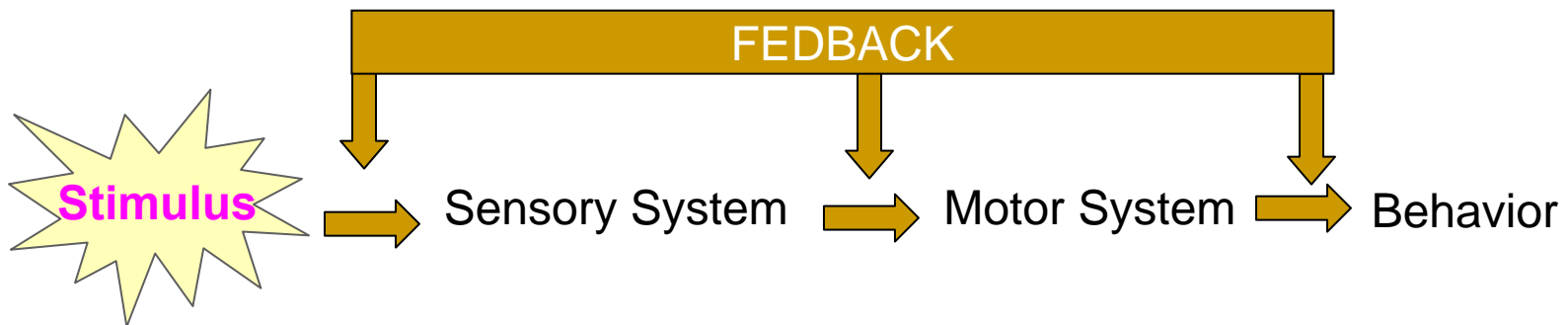


**PROXIMATE CAUSE:** During an early, critical developmental stage, the young geese observe their mother moving away from them and calling.

**ULTIMATE CAUSE:** On average, geese that follow and imprint on their mother receive more care and learn necessary skills, and thus have a greater chance of surviving than those that do not follow their mother.

# Learned Behavior

- Behavior is modified by experience (trial and error pattern).
- Flexible- Phenotypic Plastic
- Often affects even innately programmed behaviors, e.g. Fixed Action Patterns.





# Learned behavior



# Learned behavior



Copyright © 2008 Pearson Education, Inc., publishing as Pearson Benjamin Cummings.

A young chimpanzee learning to crack oil palm nuts by observing an experienced elder

# Instinct (innate) Behavior

- First time performance is completely functional
- Animals don't have to witness the behavior (inborn)
- Uniform, stereotyped
- Triggered by simple sign stimulus (sensory releaser)
- It has a strong genetic (inherited) basis: controlled by pre-programmed fixed neurological circuitries



# Innate behavior





## Innate behavior of the Cuckoo bird





## Innate behavior of the Egyptian Vulture



# Experimental studies of animal behavior in laboratory conditions



**Ivan Pavlov  
(1849-1936)**



**Burrhus Frederic Skinner  
(1904-1990)**



**Ivan Pavlov**



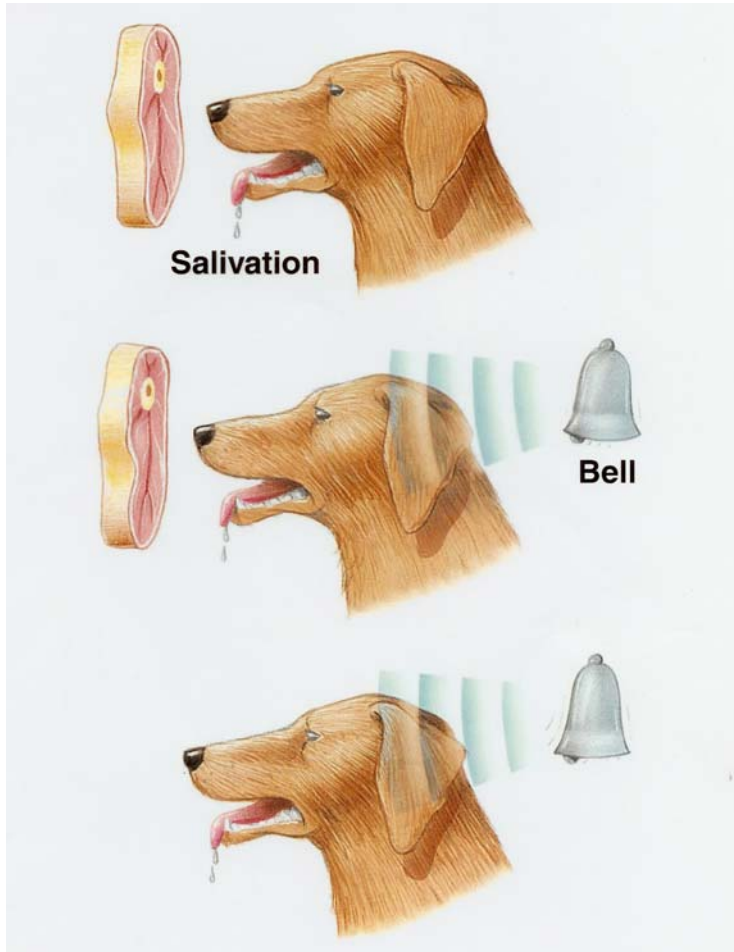
## **The Nobel Prize in Physiology or Medicine 1904**

For his research in temperament, conditioning and involuntary reflex actions of the digestive glands

Pavlov's experiment:

The original and most famous example of classical conditioning involved the salivary conditioning reflex of Pavlov's dogs.

# Pavlov's Classical Conditioning



**Before Training/Conditioning**

**Food** —————> **Salivation**

**Tone** —————> **???? (nothing)**

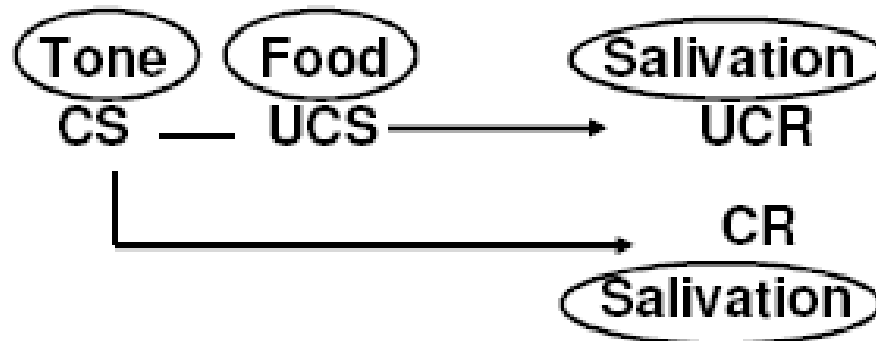
**During Training/Conditioning**

**Tone — Food** —————> **Salivation**

**After Training/Conditioning**

**Tone — Food** —————> **Salivation**

└────────────────────────────────> **Salivation**



### Definitions:

Unconditioned Stimulus (UCS): A stimulus that automatically elicits a response without any prior conditioning/learning

Unconditioned Response (UCR): That unlearned reaction/response to an UCS without previous conditioning.

Conditioned Stimulus (CS): Is a previously neutral stimulus that, through pairing with the UCS, also eventually elicits a response.

Conditioned Response (CR): That reaction/response that occurs to the CS.



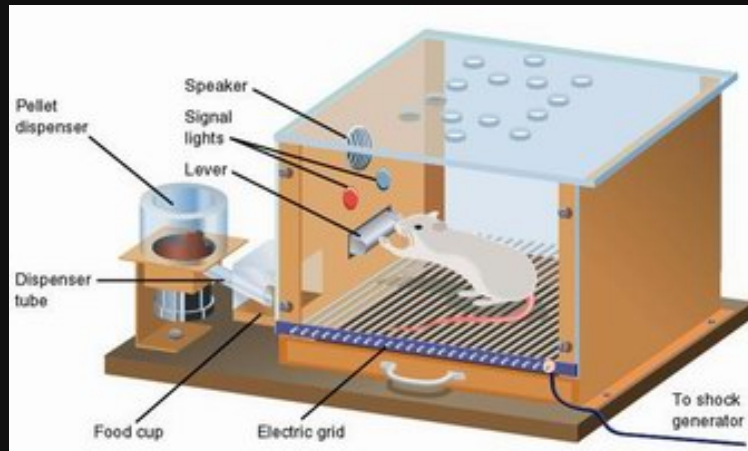
# Skinner's Operant Conditioning

The study of how behavior is affected by its consequence.



- A process where an animal learns to associate one of its behaviors with a reward or punishment and then tends to repeat or avoid that behavior.
- In different to classical conditioning the response is voluntary (it is NOT a reflex).

# Operant Conditioning: The Skinner Box



ABC

- Antecedent (previous event)
- Behavioral action
- Consequence