

1. The Study of Animal Behavior (Ethology)

Ethology is the scientific study of animal behavior, particularly under natural conditions. It seeks to understand **what animals do**, **why they do it**, and **how behavior evolved**.

Key Questions (Niko Tinbergen's Four Questions):

1. **Causation (Mechanism):** What are the stimuli that elicit the behavior? What neural, hormonal, and physiological mechanisms underlie it?
2. **Development (Ontogeny):** How does the behavior develop over an animal's lifetime?
3. **Evolution (Phylogeny):** How did the behavior evolve across species?
4. **Function (Adaptation):** How does the behavior enhance survival or reproduction?

Fields of study:

- Behavioral ecology
 - Neuroethology (behavior & brain)
 - Sociobiology (social behavior and evolution)
 - Comparative psychology (cross-species behavior)
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2. Mechanism of Behavior

The **mechanism of behavior** refers to the **physiological and molecular processes** that produce and control behavior. This includes:

- **Sensory Input:** Detection of stimuli (e.g., light, sound, chemicals)
- **Processing:** Integration by the brain or ganglia
- **Motor Output:** Muscular or glandular activity leading to action

Factors:

- **Neural mechanisms:** Neurons transmit signals to coordinate behavior.
- **Hormonal mechanisms:** Hormones regulate long-term and short-term behavioral responses.
- **Genetic mechanisms:** Genes control the development and function of neural and endocrine systems.
- **Environmental stimuli:** External cues trigger behavioral responses.

Example:

- A frog sees an insect (visual input) → neural processing → tongue strikes out (motor output)
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3. The Nervous System and Behavior

The **nervous system** is central to **perceiving the environment, processing information, and coordinating responses**.

Structure:

- **Central nervous system (CNS):** Brain and spinal cord (or ganglia in invertebrates)
- **Peripheral nervous system (PNS):** Sensory and motor neurons

Key roles in behavior:

- **Reflexes:** Automatic responses (e.g., withdrawal from pain)
- **Innate behaviors:** Genetically hardwired (e.g., fixed action patterns in birds)
- **Voluntary movements:** Controlled behaviors like locomotion, hunting, or mating rituals
- **Complex cognition:** Memory, learning, decision-making (especially in mammals, birds, cephalopods)

Example:

- Birdsong production involves specific brain nuclei (e.g., HVC, RA in songbirds)

4. Hormones and Behavior

Hormones are chemical messengers produced by endocrine glands. They **influence behavior** by modulating brain activity and physiology.

Roles:

- **Developmental effects:** Permanent changes (e.g., testosterone shapes male behavior during development)
- **Activational effects:** Temporary changes (e.g., oxytocin during mating or bonding)
- **Pheromonal communication:** Hormonal cues passed between individuals (e.g., sex pheromones in insects)

Examples:

- **Testosterone:** Increases aggression and mating behavior in males
- **Estrogen/Progesterone:** Regulate reproductive cycles and maternal behavior
- **Oxytocin:** Promotes bonding in mammals
- **Corticosterone:** Released during stress; affects escape and vigilance behavior

5. Learning Behavior

Learning is a **relatively permanent change** in behavior based on experience.

Types of Learning:

1. **Habituation:** Decrease in response to repeated, harmless stimuli
 - Example: A snail stops retracting into its shell after repeated touching
2. **Sensitization:** Increased response to a strong or novel stimulus
3. **Classical Conditioning (Pavlovian):** Associating a neutral stimulus with a meaningful one
 - Example: Dogs salivate to the sound of a bell after it is repeatedly paired with food
4. **Operant Conditioning (Trial and Error):** Learning through consequences (rewards/punishment)
 - Example: Rats learn to press a lever for food
5. **Imprinting:** Rapid learning during a critical period (often irreversible)
 - Example: Ducklings following the first moving object seen
6. **Social Learning (Observational):** Learning by watching others
 - Example: Chimpanzees using tools by imitating adults
7. **Insight and Problem Solving:** Sudden understanding of a new situation
 - Example: Crows bending wires to retrieve food

6. Finding Food and Shelter (Foraging and Habitat Selection)

Animals exhibit **adaptive behaviors** to find food and shelter, which are crucial for survival.

Foraging Behavior:

- **Optimal Foraging Theory:** Animals maximize energy gain while minimizing effort and risk.
- **Tactics:**
 - Sit-and-wait (ambush predators)
 - Active search (e.g., wolves hunting in packs)
- **Tool use:** Seen in primates, birds, sea otters

Shelter and Nesting Behavior:

- Shelter protects from predators and climate.
- Species-specific: burrows (rabbits), nests (birds), dens (carnivores)
- Some animals construct elaborate shelters (e.g., beavers build dams)

7. Migration

Migration is a long-distance, seasonal movement of animals between habitats for breeding, feeding, or climate avoidance.

Characteristics:

- **Periodic and predictable**
- Can be triggered by:
 - Photoperiod (day length)
 - Temperature
 - Hormonal changes

Examples:

- Birds migrate from temperate to tropical zones for winter
- Salmon migrate upstream to spawn
- Wildebeests migrate in search of water and grazing lands

Benefits:

- Access to resources
 - Escape from predators or harsh environments
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8. Orientation and Navigation

Animals use various mechanisms to **orient themselves** and **navigate** over short and long distances.

Orientation:

- **Taxis:** Directed movement toward or away from a stimulus (e.g., phototaxis in moths)
- **Kinesis:** Random movement affected by stimulus intensity (e.g., humidity affecting woodlice movement)

Navigation Strategies:

- **Landmarks:** Visual cues in the environment
- **Sun compass:** Position of the sun (requires internal clock)
- **Star compass:** Used by nocturnal migrants
- **Geomagnetic cues:** Earth's magnetic field (e.g., in turtles, pigeons)
- **Olfactory cues:** Smells used by salmon to return to natal rivers

Complex Navigation:

- Honeybees use the "**waggle dance**" to communicate the location of food.
- Sea turtles use **magnetoreception** for open-ocean navigation.