1. ETYMOLOGY AND DEFINITION OF ETHOLOGY

From the Latin ethologia, etymologically meaning "science of characters", derived from Ancient Greek ἠθολογία, composed of:

ἦθος (êthos) — "customs" or "manners"

λόγος (logos) — "treatise" or "discourse"

Root Terms

* **Ethos** : meaning "customs" or "behavior"

Customs/Mores: "The set of behaviors characteristic of a group of individuals, or of a single individual."

The natural or acquired behavioral patterns governing the way of life of an individual, a group, a people, or a society.

* Logos : translating as "science", "study", or "knowledge"

1.1. DEFINITION

Ethology is the knowledge of the individual and social behavior of domestic and wild animals.

1.2. KEY PRINCIPLES

- Ethology applies primarily to animals and to the animal kingdom in general.
- Ethology is **the biological study of behavior** — a scientific discipline that investigates behavior through scientific methods, chiefly observation and quantification.
- Ethology allows for a better understanding of animals; and, in the case of domestic animals, facilitates their integration into human life by improving their physical living conditions and social relationships.
- It explains behaviors observed in the field in terms of the stimuli that trigger those behaviors.
- In ethology, the ethologist is responsible for identifying the full range of factors — also referred to as stimuli — that account for a given behavior.
- Behavior may also be defined more precisely as **a modification of an organism's activity in response to a stimulus**, whether that **stimulus** is:
  - **External** (**exogenous — originating from the external environment**, e.g., sound, sign, odor, presence of another individual)
  - **Internal** (**endogenous — arising from within the organism**, e.g., hunger, fatigue, sensation of cold, hormones)
  - Or a combination of both types of signals.
- Signals may be visual, auditory, chemical, or may belong to other sensory modalities.

- Ethology studies animal behavior whether animals evolve in their natural habitat or within an experimental framework — encompassing laboratory animals, farm animals, and animals in captivity alike.

1.3. SUMMARY

- Ethology is a branch of biology that studies the behaviors of various animal species within their natural environment.
- Animal behavior encompasses all the ways in which animals interact with members of their own species, with other species, and with their environment.
- Ethology may be defined as the science of animal behavior and its causes — that is, it examines the various factors (stimuli) that influence the expression of species-specific behaviors in animals.
- The ultimate goal of ethology is to understand the behaviors and needs of animals in contact with humans: the perception of their living conditions, their subjective states (well-being, stress, evolutionary factors...), and their behavioral disorders.
- This knowledge serves to improve human–animal relationships and is a determining factor in animal welfare.

2. HISTORY OF ETHOLOGY

Pinpointing with precision the moment at which a scientific discipline is born is always a challenging endeavor. This is equally true of both animal and human ethology.

Key Historical Milestones

- **Aristotle (340–322 BC)** — *Historia Animalium* ("History of Animals") Gathered extensive information on domestic animals.

Conclusion of his work: Animals also possess insight and affection toward their families and their masters.

- **Thomas More** — *Utopia* **(1518)** Referenced various behavioral patterns of animals throughout this work.
- **Gilbert White (1720–1793) and Charles Leroy (1723–1789)** The scientific study of animal behavior finds its origins in their respective works.
- **Isidore Geoffroy Saint-Hilaire (1855)** The term **"ethology"** was used for the first time by Isidore Geoffroy Saint-Hilaire in **1855**.
- **Charles Darwin (1802–1882)** Darwin introduced the foundations of **modern ethology** by presenting the concept of an **evolutionary approach to behavior** — establishing that behavior depends both on the individual's genetics and on its environment.
  - Through his landmark theory of evolution **(1859)**, published as: ***"On the Origin of Species by Means of Natural Selection"***
  - **First book by Darwin on behavior:** *"The Descent of Man"* **(1871)**
  - **Second book by Darwin on behavior:** *"The Expression of the Emotions in Man and Animals"* **(1873)**
  - In this work, Darwin was the **first to conduct a systematic study of facial expressions** as reflections of emotional states — although his claim that such expressions are innate remains open to debate.

Darwin's famous quote: *"It is not the strongest of the species that survives, nor the most intelligent, but the one most adaptable to change."* - Charles Darwin, 1809.

- **From 1935 onward** Animal ethology experienced **remarkable growth**, driven by the **objectivist school of thought**, represented most notably by **Lorenz, Tinbergen, and Von Frisch**.

- This academic discipline gained full scientific recognition in **1973**, when **Nikolaas Tinbergen, Karl Von Frisch, and Konrad Lorenz** were awarded the **Nobel Prize in Physiology or Medicine** for their respective contributions to the study of animal behavior, each in distinct areas of the field.
- It is these three researchers who **developed the foundational ethological concepts** and established the **specific methodologies** used in the scientific study of animal behavior.

Figure 1: The founders Konrad Lorenz (left) and Nikolaas Tinbergen (right)

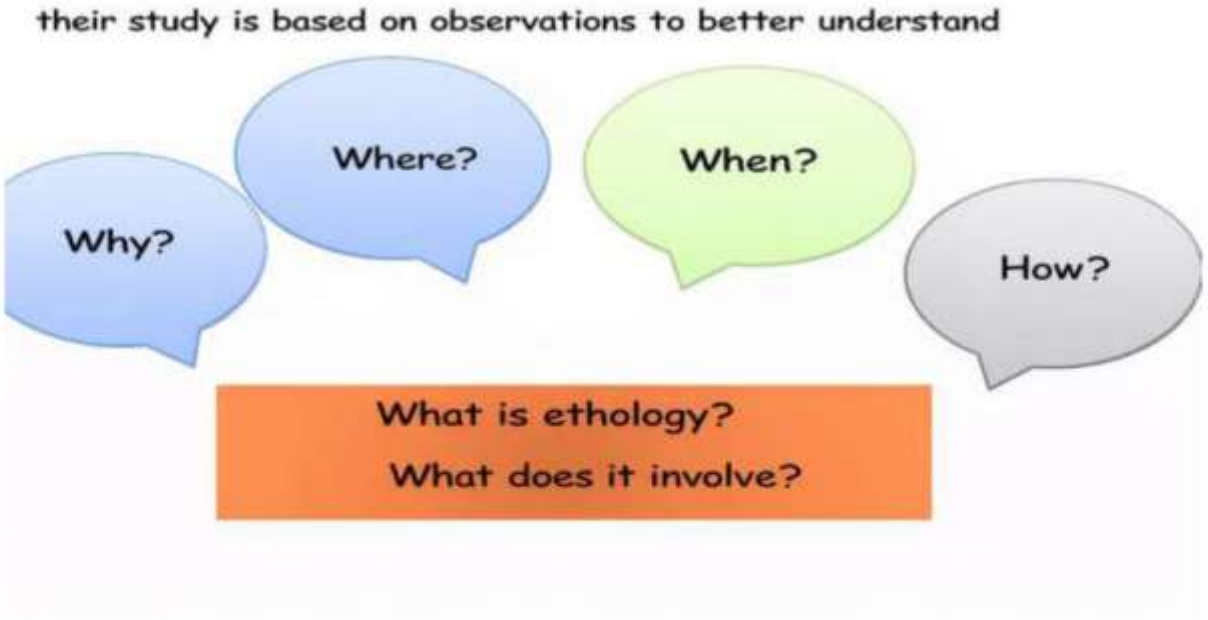


Figure 2: Key questions in ethological studies

In **1963**, Nikolaas Tinbergen published a landmark article entitled **"On Aims and Methods of Ethology"**, in which he identified **four fundamental questions** that define the scope of ethological inquiry:

- **What is the function of a behavior?** — What is the adaptive purpose of this behavior?
- **What factors trigger a behavior?** — What is the proximate cause?
- **Ontogeny:** How does behavior develop throughout the animal's lifetime?
- **Phylogeny:** How did the behavior emerge over the course of evolution?

Ethology is also concerned with the ways in which behaviors are built and shaped through what are known as:

- **Phylogenesis** — the evolution of species across successive generations
- **Ontogenesis** — the development of behavior in the individual over the course of its lifetime

Therefore, ethology addresses **behaviors in and of themselves**, as well as their **underlying causes** and their **adaptive functions**.

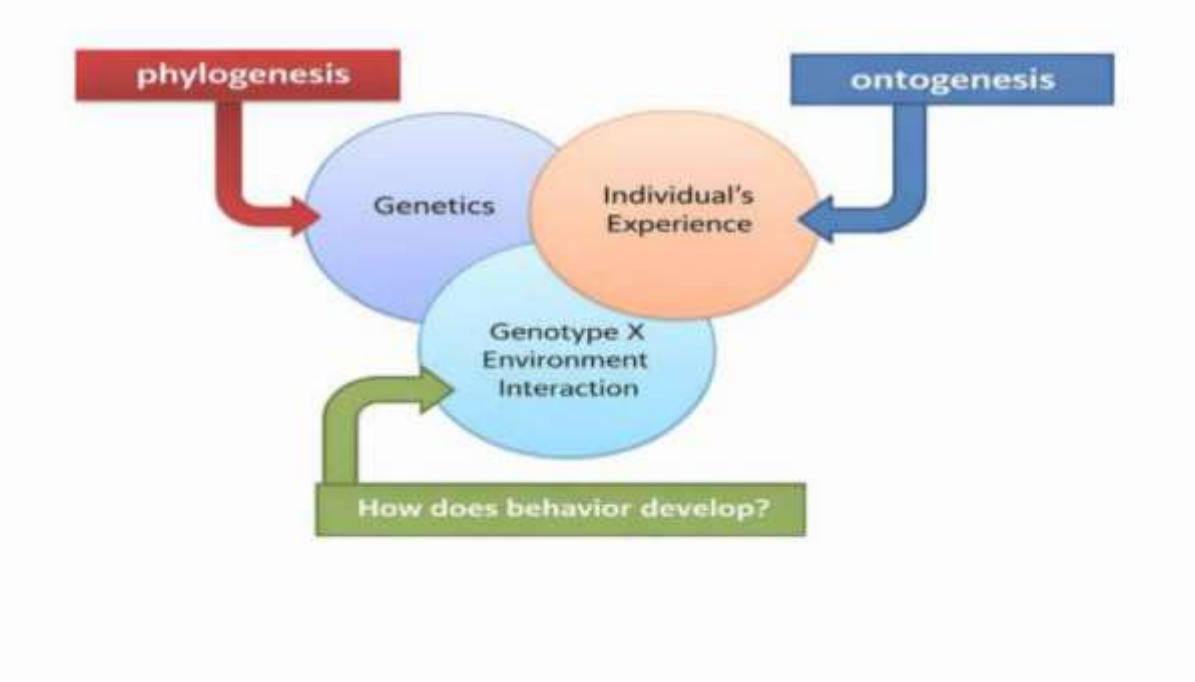


Figure 3: How a behavior develops

3. BRANCHES OF ETHOLOGY

Applied Ethology Aims to study behaviors in order to improve human–animal relationships, contribute to species conservation, and enhance animal welfare.

Cognitive Ethology Focuses on the study of animal psychological faculties, mental states, and conduct — particularly in areas such as learning, recognition, and discrimination.

Ethoecology Examines the relationship between species behavior and their environment.

Ethogenetics Investigates the genetic basis of behavior.

Neuroethology Studies the sensory processes and central nervous system (CNS) mechanisms that initiate and control specific behaviors.

Ethoendocrinology Explores the relationships between hormones and behavior.

Behavioral Embryology Examines the prenatal development of behavioral patterns.

Human Ethology Dedicated to the study of human behavior.

4. OBJECTIVES OF ETHOLOGY

Ethology aims to study behavior from **four distinct perspectives:**

Adaptive Function Studies the importance of behavior in the animal's survival and reproductive success, taking into account the influence of conspecifics and environmental factors *(distal factors)*.

Mechanisms Analyzes the internal or external factors that enable the expression of a behavior at a given moment, focusing on hormonal, nervous, and sensory mechanisms. It examines the stimuli that trigger a behavioral response and how that behavior is modified through recent learning.

Development (Ontogenesis) Observes how behavior emerges and evolves in young animals, as well as the factors that influence this developmental process - referred to as **ontogenesis**.

Phylogenetic Evolution Studies the evolution of behavior at the species level - referred to as the **phylogenesis of behavior**.

5. BEHAVIOR

What is behavior?

- Behavior is everything an individual does.
- The way in which an organism responds to an environmental stimulus.
- Behavior encompasses all the processes by which an animal perceives the external world and the internal state of its body, and reacts to the situations it perceives.
- The relationships between stimuli and responses.

5.1. DEFINITION OF BEHAVIOR

- Behavior can be defined as an action expressed by an organism in response to a stimulus — whether endogenous or exogenous — arising from a given situation. It may simply be regarded as **what the animal does**. The fundamental explanation of any behavioral activity must begin with a stimulus and end with a response.
- The behavior of a living organism represents the portion of its activity that is **observable by an observer**.
- It constitutes a **key element** of the animal's adaptive mechanisms, in conjunction with its physiological and morphological adaptations.
- As a visible interaction between the animal and its physical and social environment, behavior is studied through **ethological methods**, which allow for the analysis of the impact of different environments on animals.

5.2. BEHAVIOR AND ANIMAL PRODUCTION

- Understanding livestock behavior will facilitate handling, reduce stress, and improve both **handler safety** and **animal welfare**.
- Large animals can seriously injure handlers and/or themselves if they become excited or agitated.
- The herdsman, farm manager, animal transporter, and animal facility designer must all be informed about the **behavioral patterns of farm animals**.

5.3. TRIGGERING OF A BEHAVIOR

Two components are involved in the triggering of a behavior:

- An **external or exogenous component** — corresponding to the **stimulus**
- An **internal or endogenous component** — corresponding to **motivation**

5.4. BEHAVIOR CONSISTS OF 03 SUCCESSIVE PHASES

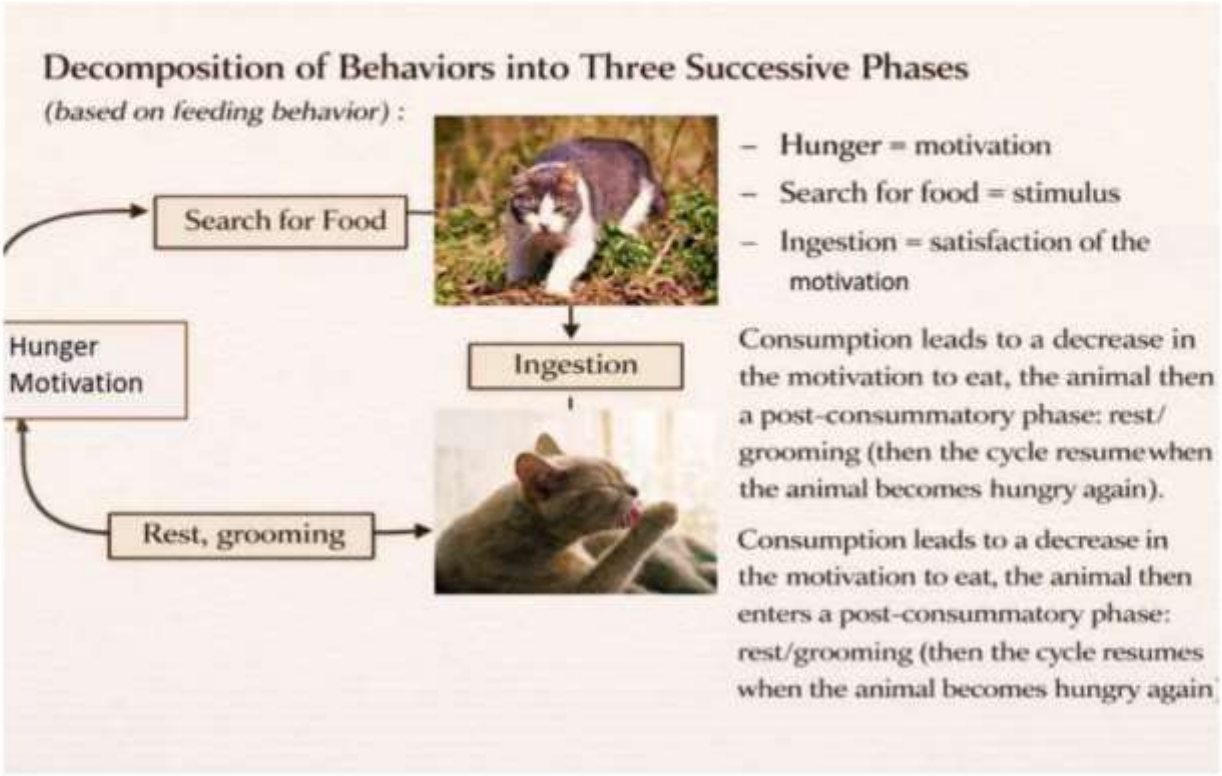


Figure 4: Diagram of feeding behavior

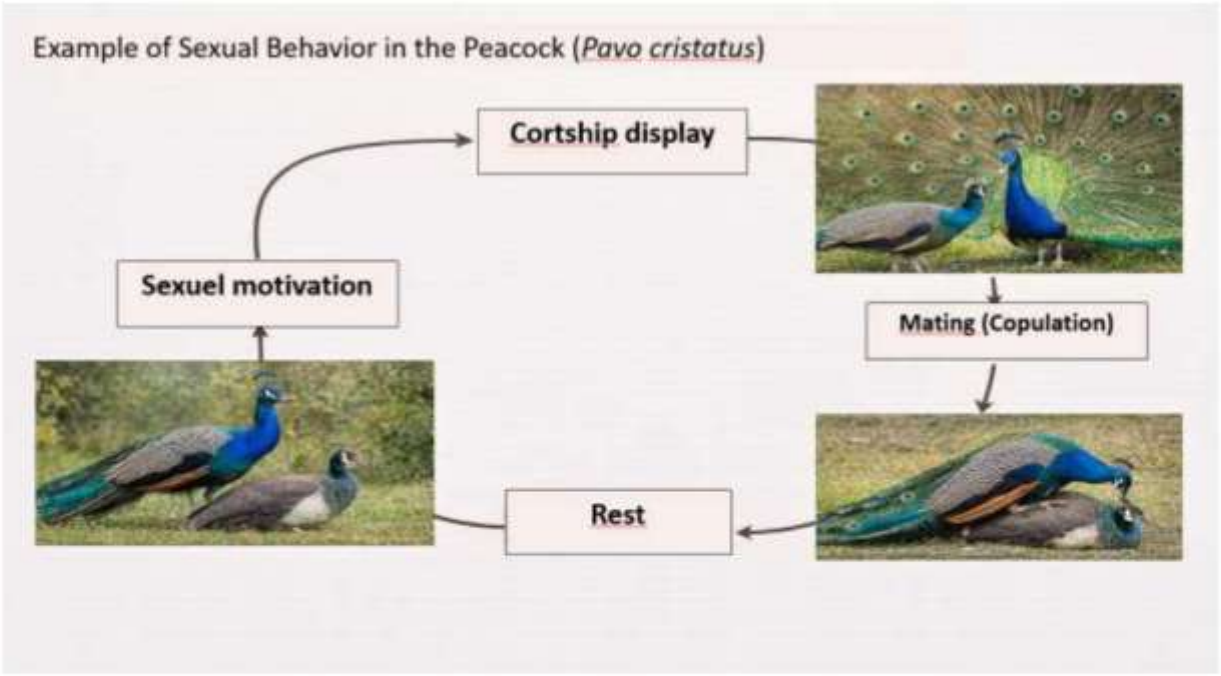


Figure 5: Diagram of sexual behavior

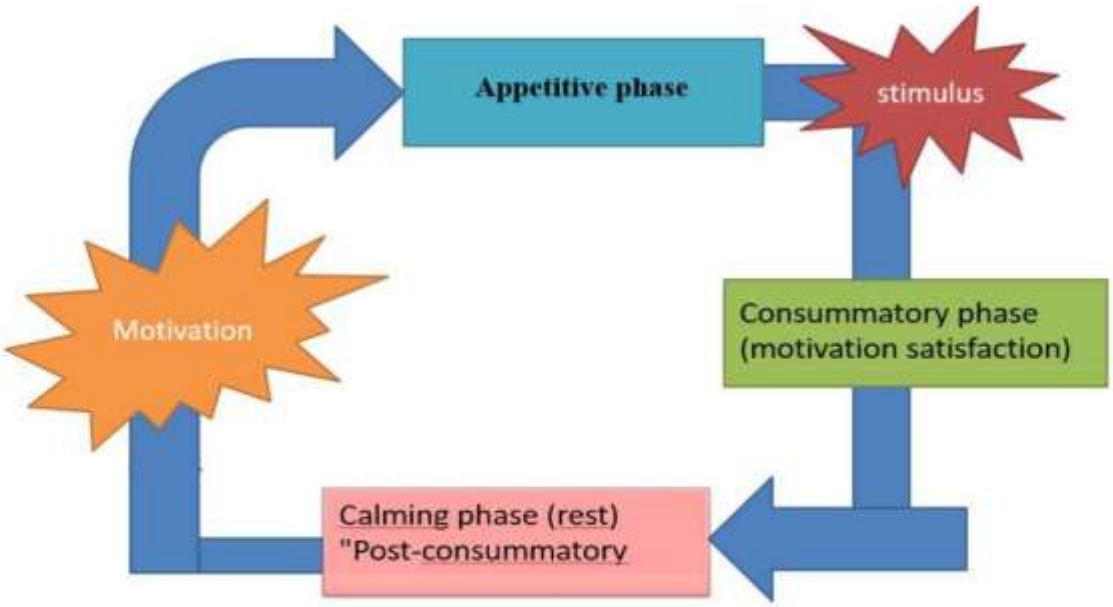


Figure 6: Generalized behavioral diagram

Motivational phase = Appetitive phase The animal actively seeks a stimulus in order to satisfy its motivation.

Consummatory phase The animal consumes — or acts upon — the stimulus, thereby fulfilling its motivation.

Appeasement phase = Refractory period A period characterized by the **absence of motivation**, marking the end of one behavioral cycle before a new one can begin.

Note: In some cases, such as in **aggressive behaviors**, the cycle is modified — there is no preceding motivational phase at the origin of the aggression. Instead, the stimulus arrives immediately and overrides all other processes. The behavior will therefore cease **only once the stimulus has disappeared**.

5.5. TYPES OF BEHAVIOR

Behaviors may be classified as:

- **Innate behavior**
- **Acquired behavior**

5.5.1. Innate Behavior *(Instinctual / Native)* — associated with phylogenesis

- An innate behavior is a behavior that is **genetically programmed** in an organism and can be performed in response to a stimulus **without any prior experience**.
- The behavior is **inherited** — transmitted from parents to offspring.
- These are behaviors that animals perform **without learning**, as they are genetically encoded.
- Innate behavior manifests in **all members of a species** — it is therefore **species-specific**.
- This behavior is expressed even in individuals **isolated from their conspecifics**.
- Innate behavior exhibits a high degree of **adaptability** and plays a critical role in **survival**.

A. Reflexes

The simplest example of innate behavior is that of a **reflex action** — an involuntary and rapid response to a stimulus or signal.

Suckling reflex: In newborns, the infant will suckle anything that comes into contact with the palate of the oral cavity. This reflex enables the newborn to feed effectively.

Figure 7: Suckling reflex in a newborn puppy

Rooting Reflex *(search reflex)* In response to contact with the muzzle, the puppy instinctively orients its head toward the source of warmth or contact. This reflex enables the newborn to locate the nipple for nursing.

Perineal Reflex When the perineal region (near the anus) is stimulated, the puppy responds with a reflex movement that facilitates the elimination of urine and feces. The mother stimulates this reflex by licking the area — a process that is crucial during the first days of life.

B. Fixed Action Patterns *(Instinct or Complex Reflex)*

A Fixed Action Pattern (FAP) is a predictable sequence of actions triggered by a specific signal, sometimes referred to as the **key stimulus** or **releaser**.

- Although a fixed action pattern is more complex than a simple reflex, it remains **automatic and involuntary**.
- Once triggered, it will be carried out to completion **even if the key stimulus is removed** in the meantime.
- Certain behavioral patterns may thus be influenced by both **instinct** *(genetic factors)* and **learning** *(environmental factors)*.

Instincts are **complex, innate, and stereotyped behavioral patterns** that hold immediate survival value for the organism and occur in response to sudden changes in the environment.

They may be regarded as **"species-specific innate motor patterns"** — behaviors characteristic of the species. These responses are transmitted from generation to generation and, having successfully withstood the rigorous test of natural selection, carry clear significance for survival.

Example: Egg Retrieval

A well-studied example of a fixed action pattern occurs in **ground-nesting waterfowl**, such as the **Greylag Goose** *(Anser anser)*.

- If one of a female Greylag Goose's eggs rolls out of the nest, she will instinctively use her bill to roll the egg back into the nest through a series of **highly stereotyped and predictable movements**.
- The sight of an egg outside the nest constitutes the **key stimulus** that triggers the retrieval behavior.

- Mother geese that retrieve lost eggs will, on average, likely have **more surviving offspring** than those that do not.

Notably, the goose will attempt to push **any egg-shaped object** — such as a golf ball — back into the nest if it is placed nearby, demonstrating the purely stimulus-driven, automatic nature of the fixed action pattern.

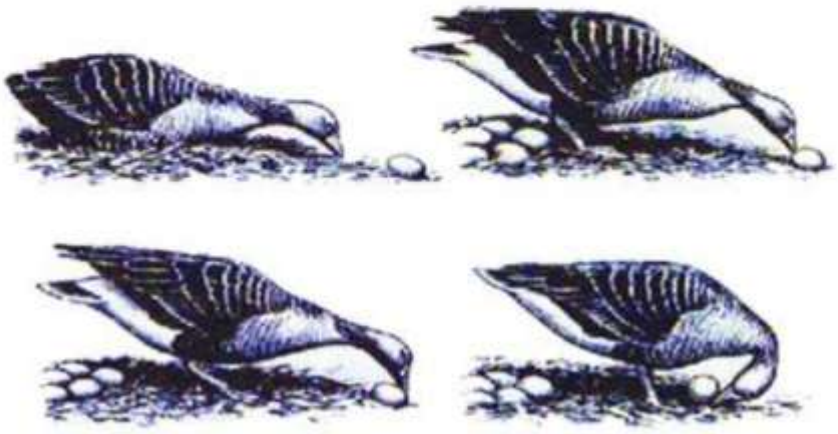


Figure 8: Egg retrieval through stereotyped movements by the Greylag Goose

Throughout the animal kingdom, numerous behaviors are **genetically encoded**, including:

- Courtship displays
- Mating behavior in most animals
- Feeding patterns
- Parental care
- Birdsong
- Wing preening and grooming
- Territoriality and aggression
- Web-building in spiders
- Walking within hours of birth *(cattle, sheep, goats, etc.)*
- Nest-building in birds

Note: These innate behaviors are critical for the **survival and conservation of the species**.

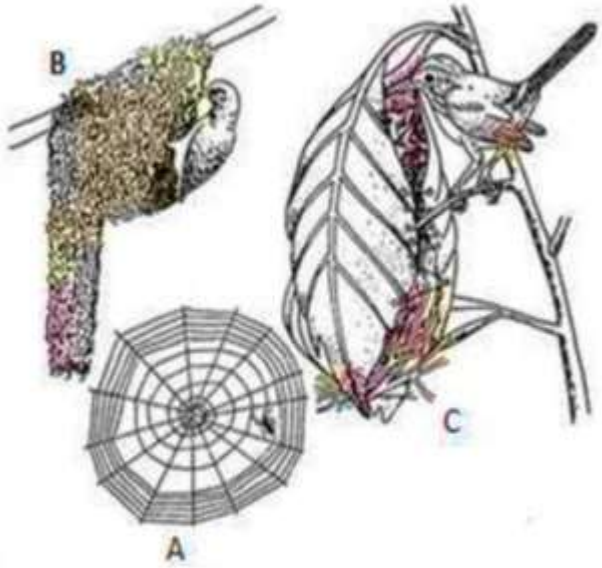


Figure 9: Nest construction

(a) Web-spinning by a spider,

(b) Nest construction by weaver birds,

(c) Nest construction by tailorbirds

Scientists test whether a behavior is innate by observing whether it is correctly performed by **naïve animals** — that is, animals that have had no opportunity to learn the behavior through experience.

This may involve raising young animals **in isolation from adults**, or in the **absence of the stimuli** that would normally trigger the behavior.

Example: Burrowing Behavior in Mice

Consider the burrowing behavior observed in the **deer mouse** *(Peromyscus maniculatus)* and the **oldfield mouse** *(Peromyscus polionotus)*. These species are closely related, yet they inhabit distinct natural environments and display markedly different burrowing behaviors:

- The **deer mouse** digs a **short and simple burrow**.
- The **oldfield mouse** digs a **long burrow** complete with an escape tunnel — or "back door" — allowing it to flee from predators.

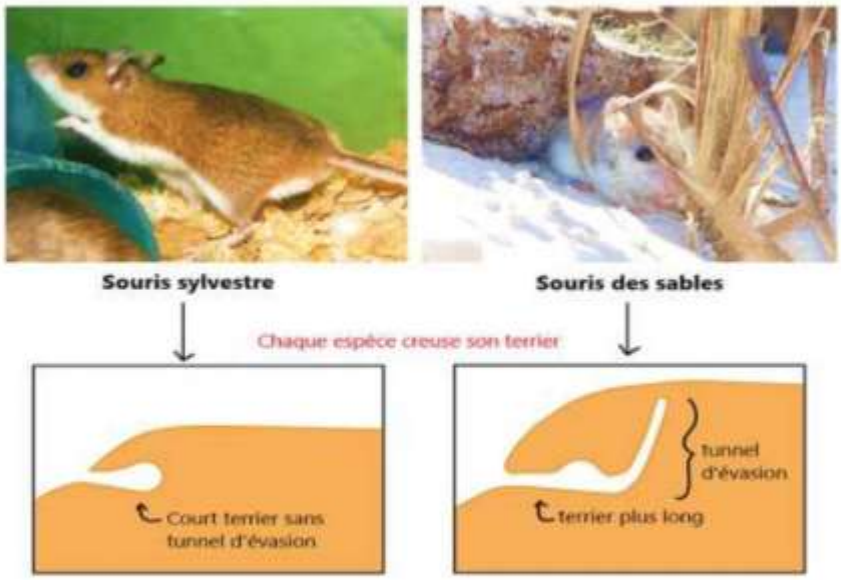


Figure 10: Type of burrow dug according to each species

- Is this difference in burrowing behavior **innate in origin**? To investigate this question, researchers raised mice of both species in a laboratory setting, with **no exposure to sand** and **no opportunity to dig**.
- They were then provided with sand — which serves as the **key stimulus** for burrow construction.
- When presented with sand, each naïve mouse dug **exactly the same type of burrow** as its wild counterpart of the same species.
- That is, oldfield mice dug a **long burrow with an escape tunnel**, while deer mice dug a **short burrow without an escape tunnel**.

The ability of the mice to construct their species-typical burrows **without ever having previously encountered such a structure** demonstrates that burrowing behavior is indeed **innate**.

5.5.2. Acquired Behavior *(Learned Behavior)* — resulting from experience and practice

Observed in an individual according to its own experience; it is associated with **ontogenesis**.

Animals adopt useful methods to survive in their environment in response to changing situations.

Learning: A process manifested through **adaptive changes in an individual's behavior** following personal experience.

Habituation: The animal becomes accustomed to a repetitive stimulus and eventually ceases to respond to it. *(e.g., a dog that stops barking after repeatedly hearing the same sound with no consequence)*

Imprinting: Certain animals learn by observing others. *(e.g., primates learning to use tools by observing their conspecifics)*

Conditioning: The animal learns to associate a stimulus with a consequence.

Reasoning: The ability to use past experiences and logical deduction to solve a new and complex problem.

A. Habituation (Non-Associative Learning)

- The animal becomes accustomed to a repetitive stimulus and eventually **ceases to respond** to it.
- Habituation is the **simplest and arguably most widespread** form of learning observed across a wide range of animal species.
- It involves a **decrease or decline in response** to repeated or continuous stimulation.
- In simple terms, an animal learns **not to respond** to constant environmental stimuli that are likely of relatively little importance.
- By habituating to these insignificant stimuli, the animal **conserves energy and time**, which can be better devoted to other essential functions.

Example 1: Over time, birds learn to **ignore scarecrows** that previously caused them to flee.

- Birds can rapidly determine that scarecrows pose no real threat.
- Studies show that the deterrent effect of scarecrows is **temporary**, as birds habituate to their presence within only a few days.

Example 2: Squirrels in an urban park **adapt to the movements** of humans and vehicles.

Note: Habituation involves **no conditioning** whatsoever. It is thought to be regulated by the **central nervous system**.

Figure 10 : Habituation in animals

B. Imprinting (Non-Associative Learning)

- A **simple and highly specific** type of learning.
- Occurs at a **particular age or life stage** in certain animals, such as ducks and geese.
- **Example in ducklings:** At birth, a duckling imprints on the **first adult it encounters** — usually its mother.
- Once imprinted, the sight of its mother triggers **survival behaviors**, such as following her everywhere and imitating her actions.

Evidence that this is not innate behavior: Konrad Lorenz (1903–1989) conducted experiments with geese in which he allowed goslings to regard him as their mother. The goslings followed him as though he were their biological mother.

It is understood that imprinting is a form of **conditioned learning**, as ducklings and goslings can also imprint on a human if they encounter one first — in which case they will follow the human just as they would their biological mother.

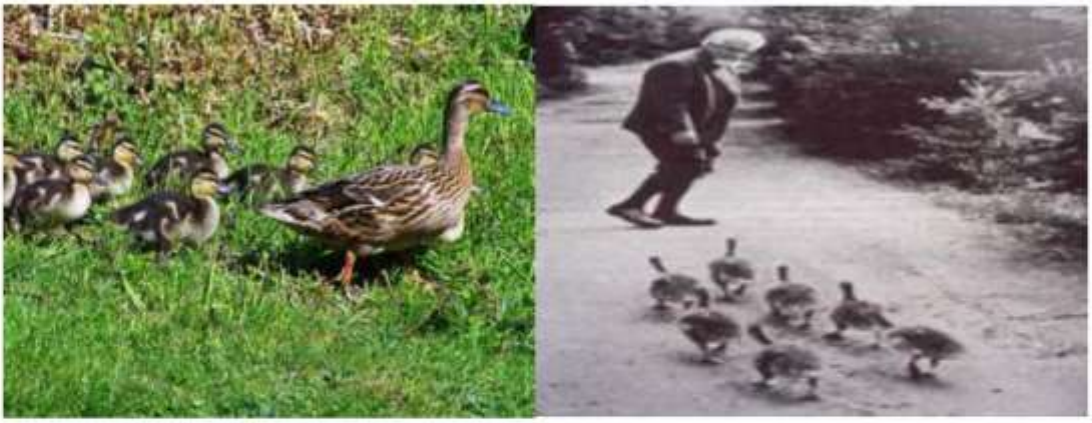


Figure 12: Imprinting behavior in ducklings and goslings

- Imprinting occurs **only during a critical period** in an animal's life.
- The duration of this period varies by species:
    - In **ducks**, the critical period falls between **13 and 16 hours** after hatching, and no imprinting occurs after **36 hours**.
    - In **chicks**, the critical period is between **5 and 25 hours** after hatching, after which imprinting becomes impossible.
    - In **human infants**, a sensitive period exists between **18 months and 3 years** of age.
- Although imprinting occurs over a **brief window of time**, its effects are **long-lasting**.
- Imprinting significantly influences **social behavior** — it enables young animals to recognize their own species, and most importantly their parents, which is **essential for their survival**.

C. Conditioned Behavior (Associative Learning)

Conditioned behaviors result from **associative learning**, which takes two forms: **classical conditioning** and **instrumental (operant) conditioning**.

C.1. Classical Conditioning

Basic principle:

- The animal learns to **associate a stimulus with a consequence**.
- A response initially linked to one stimulus becomes associated with a **second stimulus**, which previously had no connection to the first.

Famous example: Pavlov's experiments Ivan Pavlov (1849–1936), Russian physiologist, documented this type of learning through his landmark experiments.

- Dogs naturally **salivate in the presence of food** *(unconditioned stimulus)* — an innate response requiring no prior learning.
- Pavlov would **ring a bell** just before presenting food to the dogs.
- After several repetitions, the dogs began to **salivate at the sound of the bell alone**, even in the absence of food.

Key terms introduced by this association:

Conditioned stimulus: The sound of the bell

Conditioned response: Salivation trigged by the bell alone

Effect of conditioning: The bell, on its own, elicited the dogs' typical salivation response

- Food acted as a **positive reinforcement**.
- This type of conditioning can also occur with **negative reinforcement**.
- Classical conditioning is a **widespread form of learning** throughout the animal kingdom.

Pavlov demonstrated that **natural behaviors can be manipulated** through the association of stimuli.

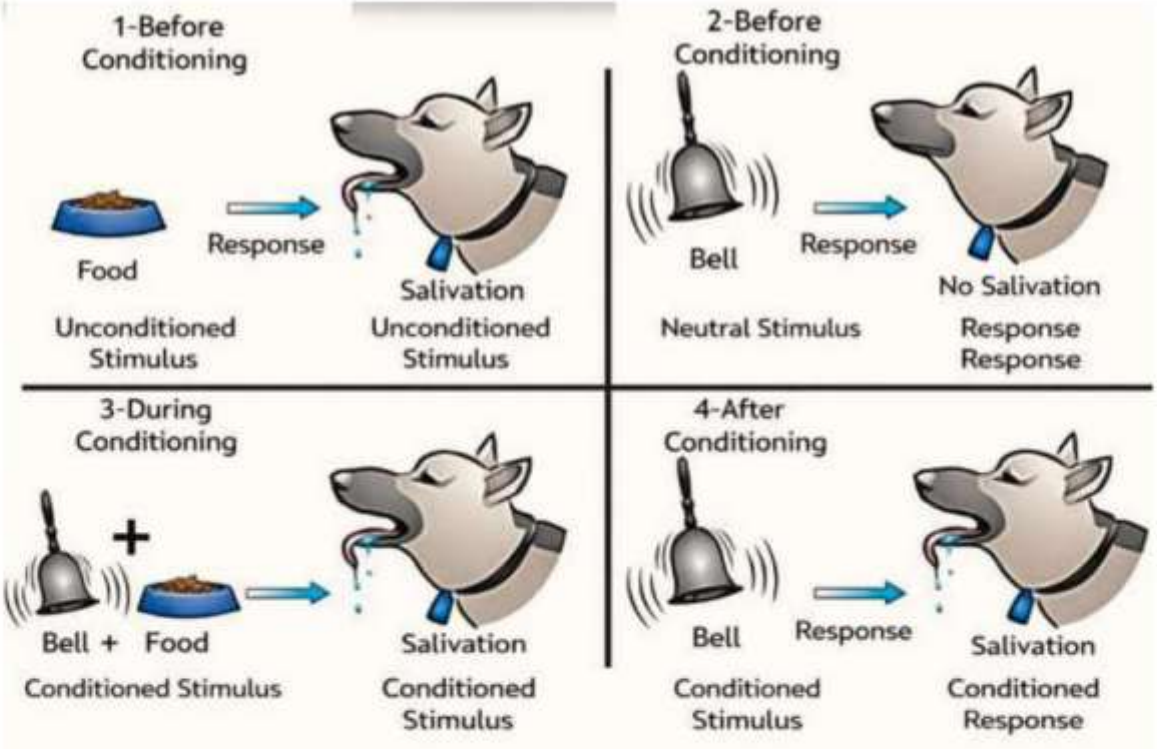


Figure 13: Classical conditioning in a dog

C.2. Instrumental (Operant) Conditioning

In operant conditioning — also referred to as **trial-and-error learning** — the animal learns by performing certain exploratory actions, such as walking and moving about its environment.

For instance, if the animal encounters food during these activities, the food **reinforces the behavior**, and the animal associates the reward with that particular action. If this association is repeated multiple times, the animal learns that **this behavior leads to reinforcement** *(reward)*.

Example: The rat in a "Skinner Box" This concept was initially proposed by **Thorndike** and further developed by **B.F. Skinner (1904–1990)**, a behavioral psychologist.

- The animal learns through **its own choices**: if a behavior is reinforced *(the animal is rewarded)*, the likelihood of that behavior recurring **increases**.
- Conversely, when a behavior yields **no benefit**, it tends to **disappear** over time.

Experimental procedure:

- Skinner placed rats in boxes equipped with a lever that could dispense either **food or an electric shock**.
- The rat moves freely throughout the box and, **by chance**, eventually presses the lever and receives a food pellet as a reward.
- Since a food reward is delivered **each time** the rat presses the lever, it associates the reward *(obtaining food)* with the behavior.
- Through repetition, the rat learns to **immediately press the lever** to receive the reward.
- Skinner's experiments also employed **punishments** — such as electric shocks — to influence the rats' behavior.
- If a rat receives a shock following a certain behavior, it quickly learns to **avoid that behavior** *(it will cease pressing the lever)*.

Skinner demonstrated that both **positive reinforcement** *(reward)* and **negative reinforcement** *(punishment)* can shape behavior in operant conditioning.

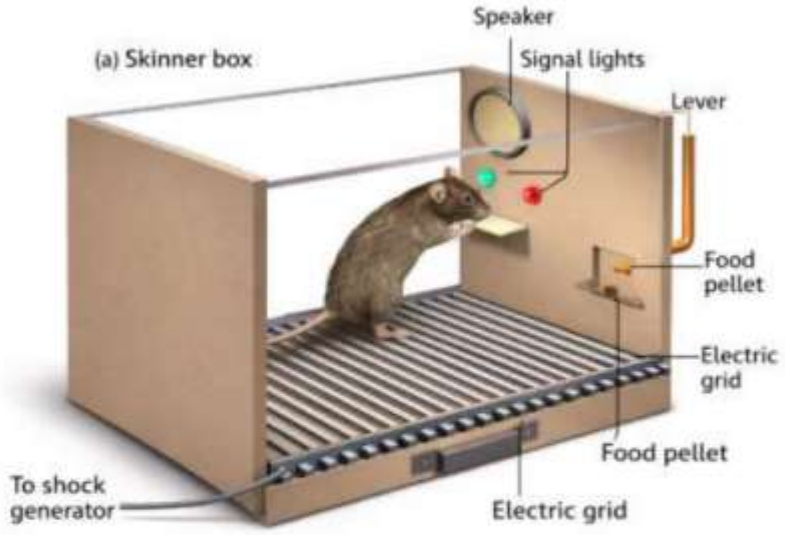


Figure 14: Rat in a Skinner Box

Table 1: Differences Between Classical and Operant Conditioning

Classical Conditioning	Operant Conditioning
Acquisition of a response to a new stimulus through association with a pre-existing stimulus	A voluntary activity that yields a reward
Allows the animal to associate events over which it has no control	Allows the animal to associate events over which it has **control**
The animal learns to predict certain events	Increases the animal's ability to **control its environment**
Rewards are associated with stimuli	Rewards are associated with **responses (behaviors)**

C.3. Latent Learning

- Latent learning — sometimes referred to as **exploratory learning** — consists of establishing associations **without immediate reinforcement or reward**.
- The reward is not apparent; however, the animal appears **intrinsically motivated** to learn about its environment.

Example: If a rat is placed in a maze with no food or reward, it will explore the maze, but rather slowly.

- If food or another reward is subsequently provided, the rat navigates the maze **rapidly and efficiently**.
- It appears that learning of the maze had **previously taken place** but remained **latent** — dormant — until an obvious reinforcement was offered.
- Latent learning allows an animal to develop a **more thorough knowledge of its environment** through exploration.

Knowledge of one's territory can be **crucial for survival** — potentially helping the animal escape a predator or successfully capture prey.

Figure 15: Latent learning in rats

D. Reasoning-Based Learning *(Insight Learning)*

In reasoning-based learning, the animal employs **cognitive or mental processes** to connect past experiences and solve problems.

Classic example: Wolfgang Köhler's work on chimpanzees (1887–1967) Chimpanzees were trained to use tools in order to obtain food rewards.

- A chimpanzee was provided with **bamboo sticks** that could be assembled to form a long pole, while **bananas were suspended from the ceiling**.
- Once the chimpanzee had assembled the long pole, it used it to **knock the bananas down** to the floor of the cage.
- Köhler concluded that the animal had employed **reasoning-based learning** to obtain the bananas.

This form of learning relies on **advanced perceptual and cognitive abilities**, such as reflection and logical reasoning.

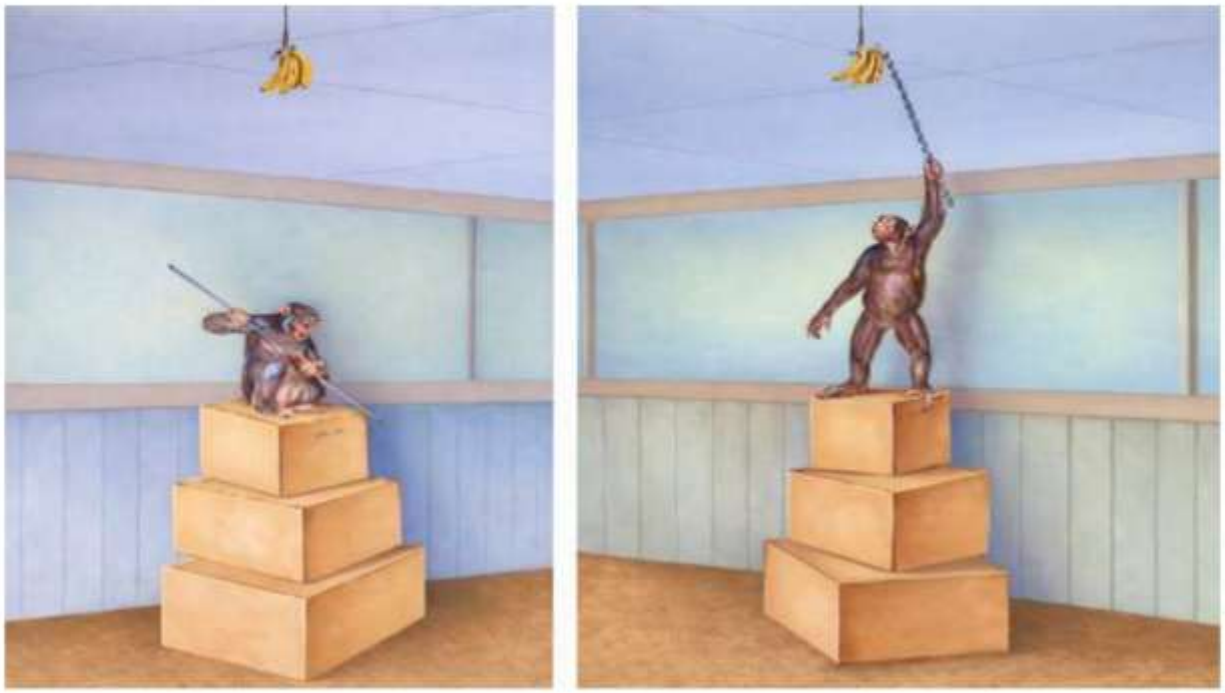


Figure 16: Reasoning-based learning in primates

6. FUNCTIONAL CLASSIFICATION OF BEHAVIORS

Behaviors are defined as interactions between an animal and its environment.

6.1. FEEDING BEHAVIOR

The complete set of behaviors involved in the **search, recognition, and ingestion of water and food**.

- Feeding behavior is closely related to the **anatomy and physiology** of each animal species.
- Animals may be classified as: **herbivores, omnivores, carnivores,** or **detritivores** *(feeding on organic debris)*.

Herbivores may be further classified as:

- **Herbivores** *(mammals, insects, fish...)* — feeding exclusively or almost exclusively on living plants
- **Granivores** — feeding on seeds and grains
- **Frugivores** — feeding on fruits

- **Nectarivores** — species such as bees that feed on nectar, a sugar-rich substance produced by flowering plants

Ingestion methods vary by species:

- The **horse** feeds using its incisors
- **Cattle** feed using their tongue
- The **sheep and goat** use their incisors and lips
- The **dog** swallows food whole

6.2. SPATIAL BEHAVIOR

Animals may inhabit **home ranges** or **territories** *(home ranges actively defended against conspecifics)*.

They may be classified as: **sedentary, migratory,** or **erratic**.

6.3. SOCIAL BEHAVIOR

The complete set of behaviors involved in **any interaction with one or more conspecifics**, excluding reproductive behavior.

Animals may be: **solitary** or **gregarious**.

6.3.1. Social Hierarchy In social groups, certain species establish **dominance hierarchies**, as observed in wolves or domestic hens *(pecking order)*.

6.3.2. Altruism A behavior in which an individual makes a **personal sacrifice for the benefit of another group member** — as seen in bees or ants, which sacrifice their own reproduction for the benefit of the queen.

6.3.3. Cooperative Behavior Animals **work together to achieve a common goal**, such as cooperative hunting in lion prides.

6.4. REPRODUCTIVE BEHAVIOR

The complete set of behaviors associated with **sexual behavior, nest construction, parturition, maternal care, paternal care, and neonatal behavior**.

Reproductive behavior represents the **primary avenue of social behavior**; animal reproductive systems may be classified as **monogamous** or **polygamous**.

6.4.1. Courtship Display Certain animals perform specific rituals or behaviors to **attract a mate**, such as birdsong or the courtship dances of flamingos *(see video)*.

6.4.2. Auditory Display Vocalizations produced by **amphibians, birds, insects, mammals, and fish** are widely used as **instruments of seduction**.

6.4.3. Parental Care Following reproduction, certain animals — such as mammals — **care for their offspring**, teaching them to hunt, to protect themselves, and other essential survival skills.

Figure 17: Courtship display in the bird-of-paradise and the flamingo

Figure 18: Flehmen response in males

6.5. JUVENILE REARING BEHAVIOR

Young animals may be classified as:

- **Nidifugous** — offspring capable of moving about almost like adults **from birth or within their first days of life** *(e.g., ostrich chicks, lambs, calves...)*
- **Nidicolous** — species whose newborns are **entirely dependent on their parents** for survival *(e.g., kittens, puppies...)*

Figure 19: Rearing of young by their mothers

The most well-known example of **paternal care** is that of the male **seahorse**, which carries the developing offspring in a specialized pouch — much like the female kangaroo, which carries her young in her ventral pouch.

Figure 20: Rearing of young by their father

6.6. ELIMINATION BEHAVIOR

The complete set of behaviors associated with **defecation and urination**, including **urine marking**. Elimination postures vary according to species:

- **Cattle:** elevation of the tail and arching of the back
- **Dog:** raising one leg to urinate
- **Cat:** specific toilet behavior
- **Birds:** defecating by leaning forward and raising the tail

6.7. GROOMING BEHAVIOR

The complete set of behaviors associated with **body care and hygiene**. The absence of grooming behavior is considered a **sign of poor welfare**.

Figure 21: Grooming and elimination behavior in various animals

6.8. SLEEP-WAKE BEHAVIOR

The complete set of behaviors governing the **alternation between periods of activity and rest**, including the search for a suitable resting place.

6.9. THERMOREGULATORY BEHAVIOR

The complete set of behaviors involved in the **thermoregulation process**.

This behavior is often associated with social behavior, involving the **drawing together or dispersal of individuals** relative to one another in response to temperature changes.

6.10. TERRITORIAL BEHAVIOR

6.10.1. Territory Marking Certain animals mark and defend a specific territory against intruders — for example, dogs urinating to mark their territory.

6.10.2. Aggressive Behavior When their territory is threatened, certain animals may display **aggressive behaviors** toward intruders.

- ✓ **Agonistic behavior** is a behavior in which an animal displays aggression or attacks another, which responds either by **counter-attacking or submitting**.
- ✓ This behavior frequently gives rise to **established patterns** in inter-animal relationships.
- ✓ In rare cases, this behavior may prove fatal; however, animals generally do not kill or seriously injure one another.
- ✓ These gestures send **signals warning other males** of their intention to defend an area or territory.
- ✓ Although agonistic behavior may appear antisocial, it plays a key role in **maintaining social order**.
- ✓ This behavior is particularly important in the management of **territories and dominance hierarchies**.
- ✓ In many species, males express a large part of their aggression through **threat displays and gestures**.
- ✓ These signals communicate to rival males the individual's **readiness to defend its territory**.

Table 2: Different types of aggressive behavior

Behavioral Category	Definition / Example of Aggression
Interspecific Aggressive Behavior	
Maternal defense *(maternal aggression)*	The mother defends her offspring against potential predators. *e.g., a ewe with her lamb attacking a dog*
Territorial defense *(territorial aggression)*	The animal attacks an intruder. *e.g., a bull in a pasture attacking a person*
Predation	The animal attacks, kills, and consumes other animals. *e.g., a lion catching and eating a zebra*
Behavioral Category	**Definition / Example of Aggression**
Intraspecific Aggressive Behavior	
Male combat *(social aggression)*	Adult males typically fight to compete for females or territory. *e.g., rams or billy goats fighting during the breeding season*
Resource defense	Aggression increases when resources are limited, as observed in cattle and other species
Intersexual conflict	Males attempt to mount females not in estrus, triggering aggressive responses. *e.g., non-estrus sows attacking a boar attempting to mount them*
Post-grouping aggression	Previously unfamiliar animals are brought together, leading to fighting, from which a social structure or dominance hierarchy emerges

6.11. SURVIVAL BEHAVIOR

6.11.1. Foraging Behavior related to the **quest for food**, such as hunting, foraging in bees *(collecting nectar and pollen)*, or grazing in cattle.

6.11.2. Predator Avoidance Defensive behaviors or escape tactics, such as **rabbits running in a zigzag pattern** to escape predators, or the **camouflage of chameleons**.

Figure 22: Survival behavior in hares and the chameleon

6.12. COMMUNICATION BEHAVIOR

6.12.1. Vocalization *(Acoustic Communication)* Animals use sounds to communicate, such as **birdsong** or the **calls of primates**.

6.12.2. Body Language *(Visual Communication)* Certain animals use postures or movements to express intentions, such as **piloerection** *(hair standing on end)* in cats as a threat display.

6.12.3. Tactile Communication Tactile communication refers to communication between animals **in direct physical contact** with one another. The antennae of many invertebrates and the tactile receptors in the skin of vertebrates play a significant role in tactile communication.

6.12.4. Chemical Signals *(Olfactory Communication)* Many animals communicate through **pheromones or other chemical signals** — for example, ants leaving scent trails to guide their conspecifics toward a food source.

- Many male mammals mark specific points within their territory with pheromones that **warn rival males** of their presence in the area.
- These same pheromones may also **attract females** during the breeding season.

6.13. CIRCADIAN AND CIRCANNUAL BEHAVIORAL RHYTHMS

6.13.1. Circadian Rhythms Animals possess **biological rhythms** consisting of daily cycles of activity and rest, synchronized with light and darkness — but capable of continuing **in the absence of these external cues** *(e.g., hibernation)*.

6.13.2. Circannual Rhythms Seasonal cycles linked to migration or reproduction, influenced by the duration of light and darkness, but **not directly by food availability**.

7. BEHAVIORAL ANALYSIS

Researchers employ **three different methods** to study animal behavior:

- Observation-based research
- Experiment-based research
- Comparative research

7.1. THE ETHOGRAM

To facilitate behavioral analysis, researchers may use an **ethogram**.

- Etymologically, the term **"ethogram"** combines *"ethos"* referring to the customs and behavior of animals — and *"gramme"* meaning a written record or graphic sign. This method may also be referred to as **"ethometry"**.
- An ethogram constitutes the **most comprehensive inventory** of all behaviors expressed by a species, whether in their natural habitat or in an experimental setting.
- It is a tool for **measuring behavior** whether innate or acquired in living organisms, both human and animal, based on systematic observations and descriptions.
- It provides a **solid and detailed research foundation**.
- According to the Larousse dictionary definition, an ethogram is *"a descriptive catalogue of the spontaneous or non-spontaneous motor activities of an animal, and their articulation into behavioral sequences."*
- An ethogram is an ethological tool used to **describe and categorize** the behaviors of an animal through a systematic inventory of observed behaviors — typically presented as a list or table — in which each behavior is precisely defined and accompanied by a detailed description of its triggering criteria and context.
- The ethogram makes it possible to **document the various actions and postures** of an animal within a given environment, whether natural or experimental.

7.1.1. Objectives of the Ethogram

- The primary objective of the ethogram is to provide a **standardized framework** for the observation and analysis of animal behavior, in order to better understand the underlying mechanisms governing the animal's interactions with its environment.

- It also enables the analysis of **behavioral variations** according to experimental conditions, thereby facilitating studies on adaptive behaviors and responses to both external and internal stimuli.

7.1.2. Constructing an Ethogram

To produce a reliable ethogram, the observer must keep several fundamental rules in mind:

- **Ensure optimal observation conditions.**
- To avoid disturbing the observed animals and risking modification of their natural behavior, the observer must remain **discreet** and blend into the surroundings as much as possible.
- A **habituation period** must be respected prior to the beginning of any experimentation.
- **Select the appropriate time and duration** for fieldwork. Depending on the time of day, the animal's behavioral cycle will differ — its actions and behaviors will vary accordingly *(rest, activity, social interactions, grooming, feeding, etc.)*.
- **Remain objective** when building the descriptive framework — listing only observable behaviors without adding direct commentary or interpretation. This approach is referred to as **naïve observation**.

For example, a species may perform what appears to be a threat display, which in the ethogram should receive a purely descriptive label such as **"head forward"**, rather than an interpretive one such as **"threatening head forward"**.

- **Describe each action meticulously** in terms of postures or movements *(formal description)*, or describe the behavior by its consequences *(functional description)*.
- **Quantify behaviors** to allow for subsequent analysis. This involves answering four basic questions: **when, where, how, and why?**
- **Classify phenomena** according to different behavioral categories *(territory, feeding, locomotion, communication, reproduction, parenting, social interactions with conspecifics, etc.)*.

7.2. DESCRIPTION OF BEHAVIORS

A **behavioral unit** is defined as an individually identifiable behavior, traceable from its beginning to its end. Observation involves the description of these behavioral units, focusing on what the animal develops in response to a given event.

The description of animal behavior may be conducted in either a **formal** or **functional** manner — two complementary yet distinct approaches.

7.2.1. Formal Description of Behavior *(Without Interpretation)*

- Focuses on the **detailed observation and classification of actions**, without taking their function into account.
- Concerned with the **form and structure** of behaviors.
- Behaviors are **precisely defined and recorded** *(e.g., posture, movements, duration, frequency)*.
- Makes **no attempt to understand** the purpose or role of behaviors within the ecosystem.

7.2.2. Functional Description of Behavior

- Aims to understand the **objective or purpose** of observed behaviors.
- Analyzes how behaviors **contribute to the animal's adaptation** to its environment.
- Based on the premise that **every behavior has an evolutionary function**, such as improving survival or reproductive success.
- The goal is to **link behaviors to their functions**, such as feeding, reproduction, or defense against predators.

Figure 23: Formal description of the mandrill's posture: lips retracted, teeth visible, crest raised.

- **Functional description:** Expression of relaxation *(appeasement behavior)*.

Figure 24: Description of flight behavior in the White Stork

Table 3: Ethogram of the White Stork *(Ciconia ciconia)*

Behavior	Behavioral Group	Formal Description
Right wing grooming	Grooming *(Bout)*	The individual scratches or preens the feathers under its right wing with its bill
Left wing grooming		The individual scratches or preens the feathers under its left wing with its bill
Head grooming		The individual scratches its head with its bill, or cleans its bill in water
Back grooming		The individual scratches or preens the feathers on the upper part of its back with its bill
Flight	Locomotion	The individual does not touch the ground and spreads its wings
Walking		The individual moves along the ground taking a minimum of 3 steps
Foraging	Feeding *(State)*	The individual pecks at the ground with its bill, transports food in its bill, or scratches the ground with its feet
Drinking		The individual takes a sip of water, then raises its head to a near-vertical position in order to swallow
Resting	Rest *(State)*	The individual has its eyes closed for at least 10 seconds, or has its bill buried in the feathers of its chest, whether seated or not
Nest building	Nest building *(State)*	The individual stares fixedly at its nest, moves building materials such as twigs or straw, or picks up materials from the ground
Conflict	Conflict *(Event)*	The individual spits at or strikes another individual with its bill
Vigilance	Vigilance *(State)*	The individual holds its neck fully extended vertically, or repositions its head at least every 10 seconds, or remains seated with eyes open
Mating	Partner interaction *(Event-Bout)*	The male individual has its feet positioned on the female's back. This behavior is recorded regardless of whether it is observed in the male or the female
Bill clattering	Partner interaction *(Event-Bout)*	The individual produces a repeated percussive sound with its bill, or emits a hissing sound while keeping its head and entire body fixed on its partner
Partner grooming	Partner interaction *(Event-Bout)*	The individual scratches or preens the feathers of its partner's body with its bill

7.3. FREQUENCY OF BEHAVIOR OVER TIME

1. State: An activity that **persists over a period of time**.

Examples: vigilance, resting, locomotion, nest building.

2. Event: A **change of state** or a rapid, discrete interaction.

Examples: standing up, alarm call.

3. Bout: A **repeated or cyclical occurrence** of a behavior occurring in phases.

Examples: scratching, play, grooming.

8. METHODS OF OBSERVATION AND QUANTIFICATION OF ANIMAL BEHAVIOR

8.1. TYPES OF OBSERVATION

There are two principal types of animal behavioral observation: **naturalistic observation** and **experimental observation**.

8.1.1. Naturalistic Observation

- Consists of observing animal behaviors **in their natural environment**, without external manipulation.
- Provides an **authentic view** of the interactions between the animal and its environment.
- Yields **ecologically valid data**, but presents certain challenges — notably the lack of control over external variables.
- Does **not allow for the investigation** of all specific hypotheses.

- Behaviors evolve in accordance with the environment. Ethologists assign **descriptive value** to behavior, which in turn contributes to increasing the animal's reproductive and survival success.

The primary objective of naturalistic observation is to **collect objective and precise data** on animal behavior, including behaviors such as foraging, reproduction, communication, play, migration, and so forth.

Figure 25: Naturalistic observation of the leopard

8.1.2. Experimental Manipulation

- Takes place within a **controlled setting** *(laboratory)* in which the researcher manipulates specific variables to observe animal responses.
- Allows for the **isolation of specific factors** and the testing of precise hypotheses.
- Used to analyze the **impact of particular stimuli** on behavior.
- May be criticized for **not accurately reflecting** the natural conditions of animals.
- Behaviors are **standardized according to external stimuli**, providing insight into the mechanisms and development of behavior at the individual level.
- Studying animals in a laboratory requires placing subjects in a **suitable and comfortable environment**.
- It is also important to bear in mind that an individual within a group exhibits **properties and behaviors that are not expressed when alone** — this is the principle underlying **animal society**.
- If the decision is made to observe a single individual in a laboratory setting, careful attention must be paid to **behaviors induced by isolation**.

Figure 26 : Types of observation

Table 4: Differences Between Naturalistic Observation and Experimental Manipulation

Naturalistic Observation	Experimental Manipulation
Conducted **in the field** — requires observing the animal in its natural environment	Conducted **in the laboratory** — the mechanisms observed are independent of the environment
A **wide variety of species** are studied, as their behaviors vary considerably across individuals and contexts	A **small number of species** are studied, as the mechanisms involved respond to the same stimuli
A **genetic basis** is attributed to behavior — consideration of **innate behavior only**	Studies behavior at the **individual level** and considers behavior to be **entirely acquired**

8.2. MEASUREMENT OF BEHAVIORS

8.2.1. Methods Used

The techniques used to measure animal behavior are diverse and adapted to the specific objectives of behavioral studies. The principal methods include **direct observation**, **video recording**, and the use of **tracking technologies** such as GPS tags and motion sensors.

A. Direct Observation

- A widely used method consisting of observing animal behavior **in their natural environment or in a laboratory setting**.
- Can be enhanced through **video recording**, enabling the capture of behaviors that are difficult to observe in real time.
- Video analysis can be performed using **video analysis software** to identify specific behaviors.
- Direct observation yields **precise data**, but may be limited by **observer bias**.

B. Indirect Observation

- **GPS tags and motion sensors** allow animal behavior to be tracked over **extended periods of time**.
- Particularly useful for animals moving freely across **large areas**, providing data on location and activity patterns.
- These technologies are **costly** and require **technical expertise** for data analysis.

8.2.2. Parameters to Consider When Quantifying Behavior

- **Behavioral latency** — the time required for a behavior to occur following a stimulus
- **Total duration** of the behavior
- **Mean duration** of the behavior
- **Behavioral frequency analysis** — measures how many times a particular behavior occurs over a given period of time; allows for the quantification of behaviors and the comparison of different contexts or animal groups; commonly used in laboratory studies, where external variables are more easily controlled.

Figure 27: Various animal species fitted with tracking transmitters

Figure 28: Tools for measuring behavior

8.2.3. Observation Conditions

In order to construct a reliable ethogram, certain **observation conditions** are required. The following criteria must be taken into account:

A. The Biological Rhythm of the Studied Animal *(diurnal, nocturnal)*

In general, observation sessions — if repeated — should be conducted at **approximately the same time** in order to respect the animal's metabolic and biological cycles.

B. The Positioning of the Observer

The observer must not disturb the observation on site, as this risks introducing **bias** into the data.

- **Concealment:** use of a hide, one-way mirror
- **Prior habituation** of the animals to the observer's presence
- **Remaining unobtrusive:** avoiding noise, refraining from direct eye contact, maintaining distance, avoiding any interaction
- **Use of viewing equipment**
- **Video cameras** may also be used, with the added advantage of providing a permanent behavioral record
- The simplest and sometimes most effective method is to **position oneself directly in front of the animals** — for this, a prior habituation phase is essential, so that subjects become familiar with the observer and are desensitized to their presence and behavior

C. The Observer's Knowledge

- **Knowledge of species-specific behaviors** — requires prior training, which is absolutely essential
- **Individual identification** — it is often necessary to be able to identify specific individuals
- **Training**
- **Marking** — attention must be paid to ensure that marking does not interfere with behavior or pose any danger to the animal

8.2.4. Sampling Methods

What is observed?

- A single individual
- All individuals collectively
- A specific behavior

8.2.5. Recording Methods

How is observation conducted?

- **Continuously**
- **Discontinuously** *(instantaneous sampling, one-zero sampling)*

A. Ad Libitum Sampling *("at will")*

- The observer records **everything they see**, whenever they choose or are able to do so.
- This method is generally reserved for **field studies** where visibility conditions are poor and individuals are not well known to the observer, leaving no alternative but to record whatever is observable.

B. Animal-Based Sampling *(Focal Animal Sampling)*

- When multiple individuals are being observed, it is impossible to follow all of them **simultaneously**.
- Attention must therefore be directed **selectively and successively** to each individual.
- A subject is selected and **all of its behaviors** — including its interactions with other individuals — are recorded over a **predetermined period of time**, after which the observer moves on to the next individual.
- It is important that the **order of individual selection** is not left to the observer's discretion, as this could introduce bias by always observing individuals in the same order.
- To avoid experimental bias, the order must be **determined in advance**, preferably at random.
- This is the **most time-consuming** method, but also the **most rigorous**.

Figure 29: Animal-based sampling

C. Behavior-Based Sampling *(All-Occurrences Sampling)*

- Focuses on a **specific behavior**, regardless of which individual performs it.
- The behavior is recorded **every time it occurs**.
- Where necessary and possible, the **identity of the individual** that expressed the behavior and/or the behaviors that **immediately preceded or followed** it are noted.
- This method is particularly appropriate when the behavior under study is **not frequently observed**.

D. Scan Sampling

- Focuses on **all individuals** and their behaviors simultaneously.
- The observer records behavior at **regular intervals**, providing an estimate of the **duration of activities**.
- Can be applied to a **single individual or to multiple individuals**.
- In the latter case, the observer's gaze **sweeps across the observed group** and records their behaviors at **predetermined time intervals** *(e.g., every 5 minutes — 12 observations per hour)*.
- This method is particularly suited to measuring the **spatial distribution** of a group of individuals relative to one another — allowing measurement of inter-individual distances *(less than 5m, more than 5m, etc.)* and the number of individuals within a given radius.
- **Instantaneous sampling** is mandatory in this case.

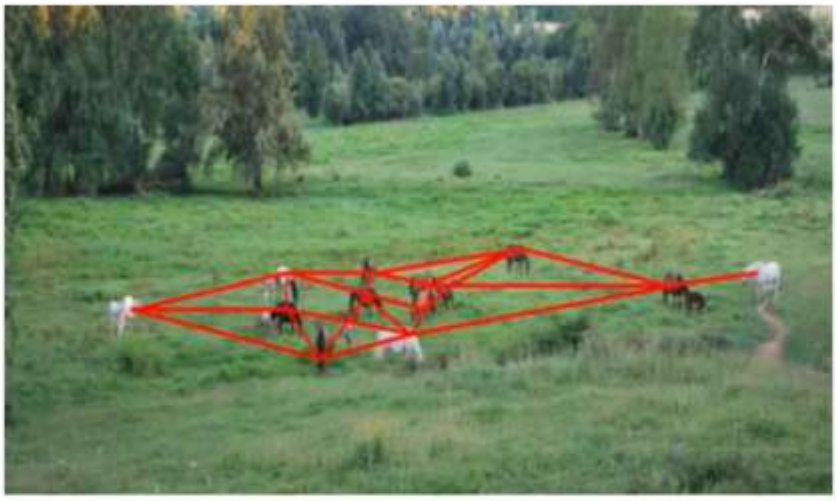


Figure 30: Observation of the spatial distribution of a group of individuals

E. One-Zero Sampling

- The observer records whether a behavior **is expressed (= one) or not (= zero)** during a given time interval.
- Time intervals must be **short and well-spaced**.
- Whether the behavior occurs **once or multiple times** during the interval is irrelevant — it is always recorded as **"one"**.
- The advantage of this method is its **simplicity**: it can be used by an inexperienced observer, or when it is difficult to define the **beginning and end** of a behavior *(e.g., play behavior)*.
- However, for one-zero sampling to be valid, the duration of the chosen time interval must be **short relative to the duration of the behavior** and to the time separating two successive occurrences of that behavior.
- The main **drawback** of this method is the **loss of information** regarding the frequency and duration of the behavior.

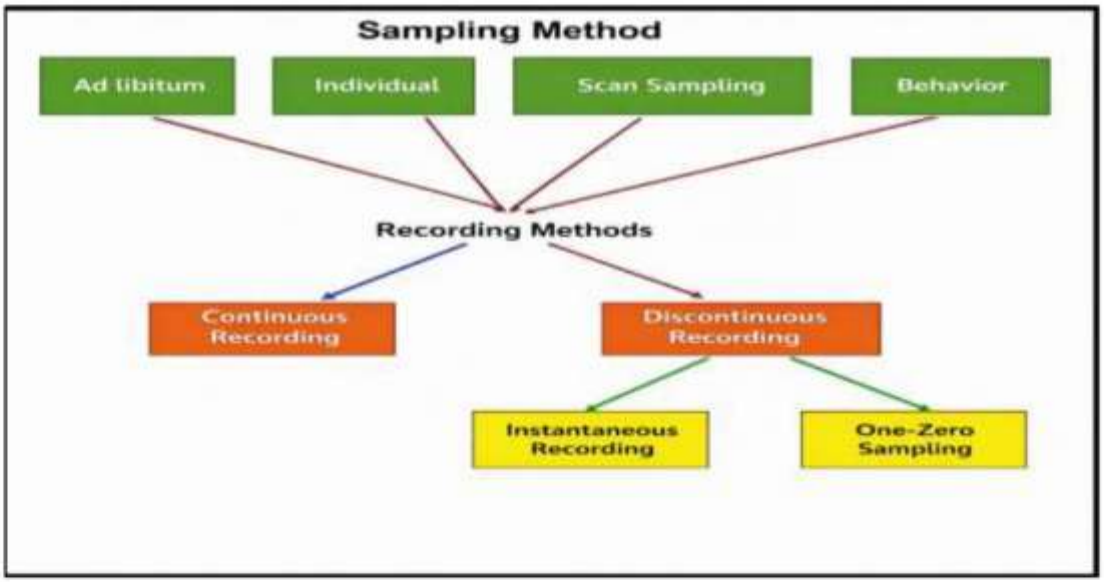


Figure 31: Sampling and recording methods

8.3. METHODS OF BEHAVIORAL QUANTIFICATION

Once a behavior has been described, it can be **measured and quantified**. Studying an animal's behavior means understanding **what it does, where, when, how, and why** it acts in a particular way.

- **Where:** Refers to the **location** at which the behavior occurs — this may be a specific place *(such as a territory)* or the **relative positions of individuals** with respect to one another.
- **When:** Refers to the **timing** of the behavior — whether a season, a time of day, or a particular stage in the animal's life *(such as age)*.
- **How:** Explores the **manner** in which the behavior is carried out — including the observed movements and the stimuli *(internal or external)* that trigger the behavior.
- **Why:** Seeks to understand the **reasons** behind the behavior — that is, its **causes and function** *(e.g., survival, reproduction, or adaptation)*. These points collectively allow for a more thorough analysis and interpretation of observed behaviors.

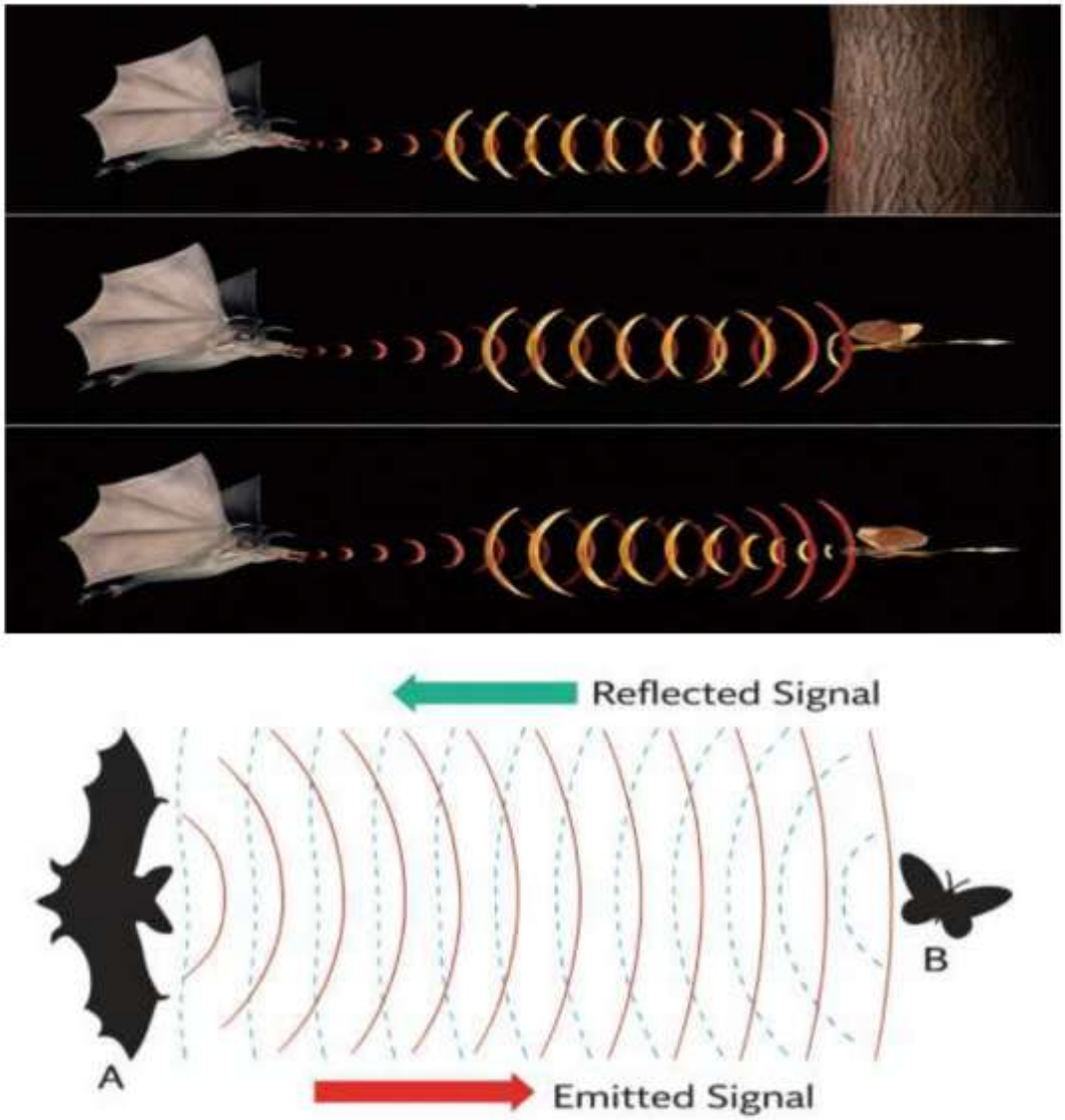
9. ANIMAL BEHAVIOR: COMMUNICATION AND REPRODUCTION

9.1. ANIMAL COMMUNICATION

Communication consists of **simultaneously sending and receiving signals** using multiple senses *(such as vision, hearing, or smell)*. These senses must function effectively so that each individual can be recognized by others of its species. Each organism can transmit messages through a particular sensory channel *(e.g., sounds for hearing)* and can also receive messages through that same channel. What matters is that the **received message is clear** — if the message is misunderstood, it indicates that the sender failed to transmit it effectively.

Communication occurs:

- Among **individuals of the same species**
- With **other species** *(e.g., brightly colored frogs signal their toxicity)*
- With **human beings**
- Through **auto-communication** *(e.g., bats emit signals that bounce back to provide information about environmental elements)*



Figures 32 : Auto-communication in bats

Functions of animal communication:

- Attracting a mate
- Defending a territory
- Indicating a food source
- Warning other animals of danger
- Establishing dominance or submission

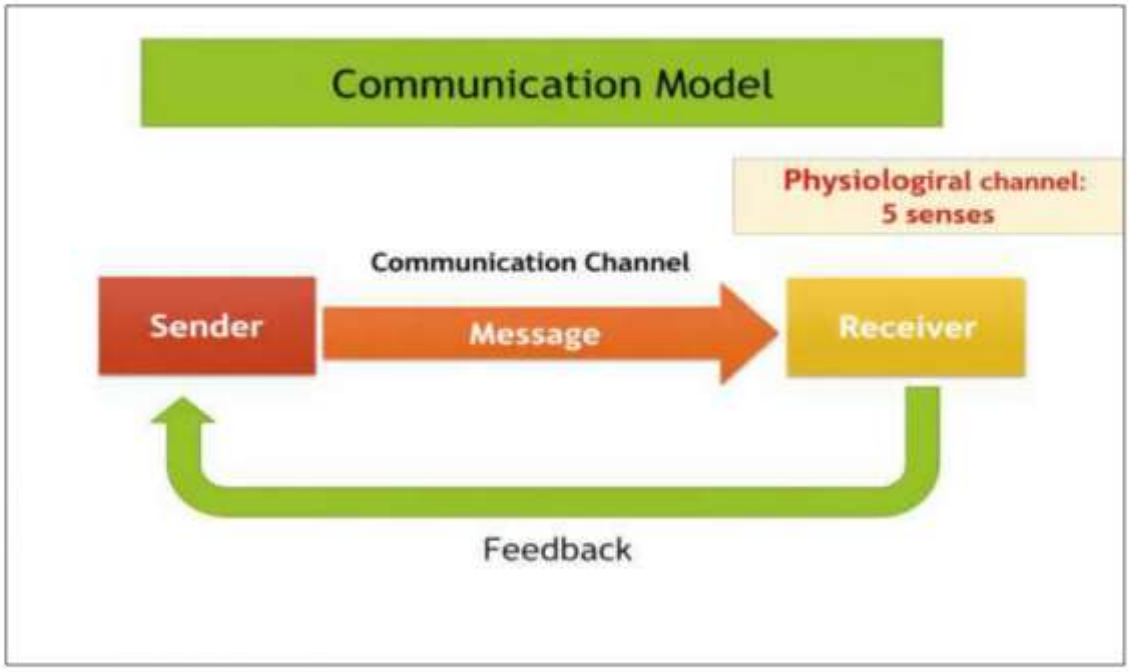


Figure 33: Communication diagram

9.1.1. Acoustic or Vocal Communication *(Vocalization)*

- **Arthropods and vertebrates** frequently use acoustic communication.
- Producing sounds requires energy, but functions effectively **both day and night**.
- Sound waves have the advantage of **bypassing obstacles**, allowing signals to be emitted or perceived even when the animal is concealed or in open terrain.
- Sounds can convey a **wealth of information** through variations in frequency, duration, volume, and pitch.
- Acoustic communication systems are **adapted to the environment** in which they are used and to their specific function.

Examples:

- Birds of tropical forests emit **low-frequency sounds** that travel easily through dense vegetation.
- Primates of tropical forests produce sounds that **propagate over long distances**.
- Territorial birds frequently sing from **elevated perches** to maximize signal effectiveness.
- Small birds emit **alarm calls** to warn conspecifics of potential danger.
- The most complex acoustic signals studied include **birdsong** and **human speech**.

9.1.2. Visual Communication

- Many animals rely on visual communication as it allows for the **rapid transmission of large amounts of information**.
- Animals with well-developed eyesight — such as **cephalopod mollusks, arthropods, and most vertebrates** *(with the exception of most mammals)* — are generally capable of perceiving color.
- Certain species, including **fish, reptiles, and birds**, display vivid colors that frequently serve as **communicative signals**.
- In contrast, most **mammals** display simple, dark coloration and lack color vision, as they are typically **nocturnal** — a trait inherited from their insectivorous nocturnal ancestors.
- **Primates** are an exception: they possess color vision and also make use of colored signals.
- A visual signal may be **permanent**, such as the colorful facial markings of the male mandrill.
- Occasionally, the signal is **concealed on a less visible part of the body** and then displayed suddenly.
- For example, certain lizards — such as the **green anole** — can change color through the action of **pigment cells** in their skin.

Limitations of visual communication :

- Environmental obstacles can **obstruct the line of sight**
- Signals may be **difficult to perceive at distance**
- They are **ineffective at night**
- They may **attract predators**

Figure 34: Visual communication — mandrill and green anole lizard

9.1.3. Chemical or Olfactory Communication

- **Pheromones** are chemical substances produced by an animal that influence the behavior of other members of the same species. These signals are detected through the sense of smell via the **vomeronasal organ**.
- **Territory marking:** Many males — particularly among mammals — deposit scent markings to warn rival males and attract females that are ready to reproduce.
- **Pheromone persistence:** Pheromones used for territory marking or mate attraction are **longer-lasting**, owing to their heavier chemical structure.
- **Airborne pheromones:** Certain pheromones — such as those produced by female butterflies to attract males — are lightweight and **disperse through the air**, detectable over distances of several kilometers.
- Pheromones thus allow animals to simultaneously **mark their territory** and convey information regarding their identity, sexual status, social group membership, or the proximity of a food source.
- **Insects and mammals** are the species that rely most heavily on this form of communication.

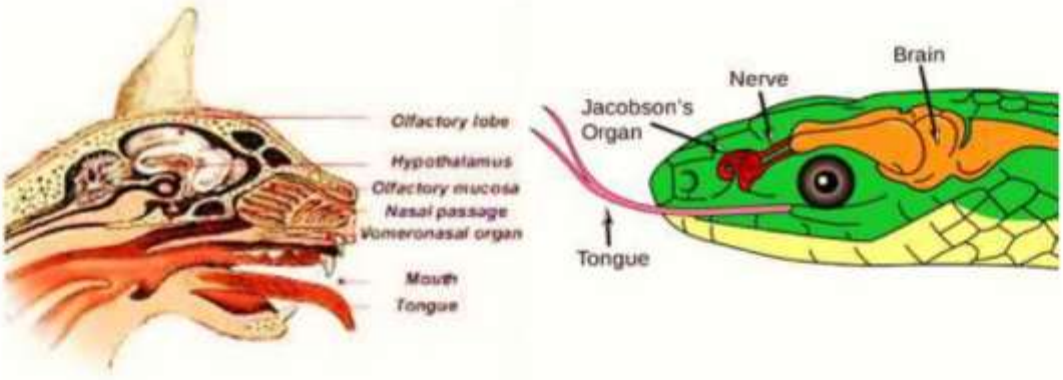


Figure 35: The vomeronasal organ (Jacobson's organ), found in several species, enables the detection of chemical stimuli (pheromones)

Note: **Pheromones** are odorous or sapid *(taste-bearing)* substances released outside the organism that trigger a specific, unconscious reaction — of a sexual, maternal, social, or aggregative nature — in individuals of the same species *(intraspecific communication)*.

Hormones are secreted by glands, released into the bloodstream, and act upon the organism of the individual that produces them. **Pheromones**, by contrast, are released **outside** the organism — not into the bloodstream.

Ectohormones are involved in **interspecific communication**. First discovered in insects in **1959**, they are also present in mammals and reptiles.

In male ruminants, pheromones are responsible for the **female effect** *(females in sexual activity)*: influencing testicular function, testosterone secretion, and libido.

In female ruminants, pheromones mediate the **male effect**:

- Advancing the onset of puberty *(Vandenbergh effect)*
- Inducing the appearance of estrus and partially synchronizing it in anestrous females brought into contact with a male *(male effect or Whitten effect)*
- Facilitating the recognition of estrous females by males *(via the Flehmen response)*
- Contributing to the recognition of the young by its mother, and to the mother–offspring bond

9.1.4. Tactile Communication

Tactile communication is a form of communication in which animals **make physical contact** with one another. In invertebrates, **antennae** play a key role, while in vertebrates, **tactile receptors in the skin** are the primary mediators.

Examples:

- Birds **preening the feathers** of other birds
- Primates **grooming one another**
- Physical contact **during mating**

Figure 36: Interspecific tactile communication

- Parents and offspring, sexual partners, and members of the same social group are those that **most frequently engage** in tactile communication.

Examples:

- A wolf **licks the muzzle** of the dominant wolf to signal complete submission.
- Spiders **vibrate the web** to communicate with one another when located at different points on it.

Figure 37: A wolf licking the muzzle of the dominant wolf as a display of complete submission

9.2. REPRODUCTIVE BEHAVIOR

- Reproductive behavior encompasses both **sexual and parental behaviors**.
- It is a **motivated behavior** that can be schematically divided into a sequence of three phases, respectively referred to as the **"attraction phase"**, the **"appetitive phase"**, and the **"consummatory phase"** — by analogy with the sequences observed in feeding behavior.
- This distinction has been extensively used by both ethologists and experimental psychologists in the investigation of the mechanisms controlling numerous motivated behaviors, such as predatory or feeding behaviors.

9.2.1. Attraction Phase

This initial phase consists of the **identification and selection of a potential sexual partner**.

- It is often marked by **visual, olfactory, or auditory signals** designed to attract attention.
- **Pheromones** play an essential role in this phase, contributing to the recognition and mutual attraction between partners.
- In certain species, specific behaviors such as **dances or courtship displays** are performed to enhance attractiveness.
- **Examples:** In birds, males frequently use **songs or vivid coloration** to court females.
- The coloration of various tissues or body parts — such as **bird plumage**, or the **turgescence and coloration of the anogenital region** in many primates — constitutes attractive visual signals that advertise the physiological receptivity of a potential sexual partner.

- The **vocalizations of birds and amphibians** may also play an important role in attracting a sexual partner.

9.2.2. Appetitive Phase

This intermediate phase is characterized by **desire and the active search** for contact or proximity with the partner.

- It may include **seductive behaviors and exploratory interactions**.
- The appetitive phase is modulated by hormones such as **dopamine**, which is involved in motivation and the anticipation of reward.
- This phase may also include **preparatory rituals** preceding sexual approach, and is often expressed through an **increase in motor activity**, comprising a sequence of investigation and orientation toward the opposite-sex partner.
- **Examples:** In mammals such as felids, individuals display **rubbing or marking behaviors** to signal their availability.

9.2.3. Consummatory Phase

This phase corresponds to **mating or the sexual act itself**, involving engagement in reproductive behavior, the complexity of which varies according to species.

- Although this phase involves interactions in which **each partner's behavior depends on that of the other**, it nonetheless unfolds with **considerable behavioral variability**, determined by the anatomical and physiological differences between species.
- The **latency between intromission and ejaculation** can be highly variable — very brief in ruminants, yet requiring a **prolonged series of intromissions** in mice.

Finally, it is worth noting that once mating has occurred, it is frequently followed by a **refractory phase** *(post-consummatory phase)* during which the level of sexual activity is **markedly reduced** in both sexual partners.

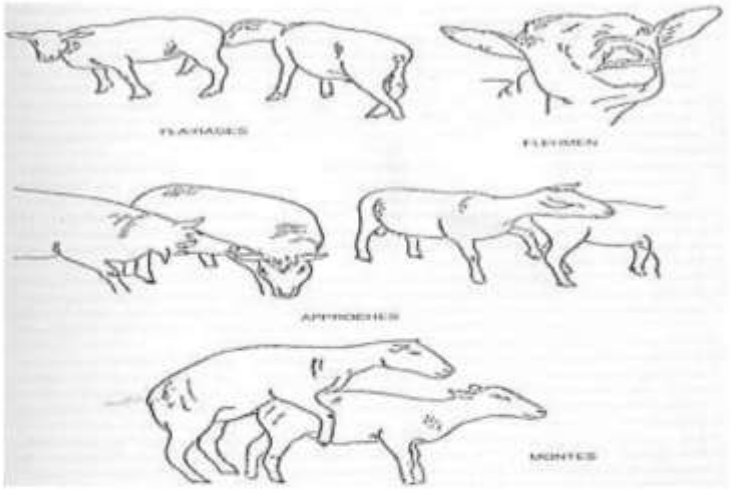


Figure 38: Reproductive behavior in sheep

10. SPECIFICITIES OF BEHAVIORAL DEVELOPMENT IN DIFFERENT VETERINARY SPECIES OF INTEREST

10.1. BEHAVIORAL DEVELOPMENT OF THE DOG

The behavioral development of the dog — or **behavioral ontogenesis** — encompasses all successive learning phases from conception through to adulthood. The future behavior of the puppy will depend **80% on learning acquired during these phases**, and **20% on heredity**. These periods, during which behavioral development evolves, are indispensable to **socialization**, as it is during these so-called **"sensitive"** or **critical periods** that both **interspecific and intraspecific relationships** are established.

10.1.1. Prenatal Period

- Corresponds to the puppy's **in utero life** *(while still in the mother's womb)*.
- Lasts approximately **63 days** *(2 months)*.
- While still in the womb, the puppy **cannot see or hear**, as its visual and auditory systems are not yet functional.
- The puppy can already move its **paws and head** slightly, and may exhibit **suckling behaviors** that prepare it for nursing once born.
- It already possesses **tactile and olfactory capabilities**.

- **Maternal influence and in utero effects:** Behavioral development is influenced from the prenatal period by the **mother's stress levels**, which can affect the future reactivity of the puppies.
- Stressed mothers may produce **more anxious and less adaptable** puppies.
- Exposure to prenatal hormones such as **cortisol** can influence the temperament and adaptability of puppies throughout their lives. Elevated in utero cortisol levels are associated with **increased stress sensitivity** after birth.

10.1.2. Neonatal Period *(from birth to 2 weeks)*

- **Limited sensory development:** During the first weeks, puppies are **deaf and blind**; their behavior is largely based on reflexes such as **suckling and rooting**, which ensure their survival.
- **Importance of tactile contact:** The newborn puppy is incapable of independently regulating its body temperature, and generally **warms itself through contact with its mother and littermates**. Maternal contact is therefore crucial at this stage, as it regulates body temperature and stimulates neuronal development, promoting better long-term behavioral adaptation.
- The newborn puppy's **neurological and sensory capacities** are limited due to an incompletely developed nervous system — a characteristic feature of **nidicolous species**.
- As the puppy is not yet truly mobile, it moves very little in early life — it cannot walk, but is capable of **crawling**.

Due to its sensory and neuronal immaturity, the newborn puppy does not yet have the capacity to produce many behaviors. It exhibits **reflexes**, sometimes referred to as **primary reflexes**.

A. Reflexes of the Puppy from Birth to 2 Weeks

Suckling reflex Essential from birth, this reflex enables the puppy to nurse and feed. Upon contact with the mother's nipple, the puppy automatically begins to suckle — a reflex that is **vital for survival** during the first weeks.

Rooting reflex *(search reflex)* In response to contact with the muzzle, the puppy instinctively orients its head toward the source of warmth or contact, enabling it to **locate the nipple** for nursing.

Perineal reflex When the perineal region *(near the anus)* is stimulated, the puppy responds with a reflex movement that facilitates **elimination of urine and feces**. The mother stimulates this reflex by licking the area — a process crucial during the first days of life.

Labial reflex The puppy's lips and tongue orient toward whatever stimulates them — namely, **the mammary gland**.

Swallowing reflex: The act of swallowing food present in the mouth allows the young puppy to **properly ingest its mother's milk**, ensuring growth and good health.

Rooting/burrowing reflex: This reflex consists of the puppy **pressing and pushing its head against surfaces**, helping it navigate toward a heat source and find its way to the nipple, thereby facilitating nursing.

Withdrawal reflex: When the paws or body of the puppy are stimulated, it responds with a **rapid withdrawal of the limb** — a protective reflex that helps avoid dangers and adjust to the environment.

Magendie reflex *(head rotation):* When placed on its back, the puppy attempts to **turn its head to the side** to regain a normal position. This reflex promotes adaptation to gravity and contributes to early motor development.

Thermotaxis reflex *(thermal orientation):* The puppy is capable of detecting and instinctively **orienting toward heat sources** — a behavior that helps it remain close to the mother and littermates in order to maintain stable body temperature.

Figure 39: Puppies during the neonatal period

10.1.3. Transition Period *(2 to 3 weeks)*

- Upon entering the transition period, **primary reflexes begin to gradually disappear**, owing to the continued **cerebral maturation** of the puppy, which renders it increasingly capable of controlling its reactions and therefore its behaviors.
- **Opening of the eyes and ears:** At this stage, puppies begin to **see and hear**, enabling them to respond more actively to their immediate environment.
- **First social behaviors:** Puppies begin to interact with their littermates and develop **primitive play behaviors**, essential for learning social communication and hierarchy.

Figure 40: Opening of the puppies' eyes

10.1.4. Socialization Period *(3 to 12 weeks)*

- This period is **longer than the preceding ones**, reflecting the fact that a **very large number of learning experiences** will take place during this time.
- **Heightened sensitivity to social interactions:** This period is crucial for socialization, as puppies are particularly receptive to social stimuli.
- At this age, puppies are described as **neophilic** — they are attracted to novelty. Spontaneously, a puppy in the socialization phase will approach, and olfactorily and sometimes tactilely explore *(e.g., by nibbling)* any new object or individual *(dog, human, cat, etc.)* it encounters.
- **Note:** Contact with other dogs and humans allows puppies to develop **social skills** that reduce fear and promote good behavioral adjustment.
- **Habituation to diverse environments:** Exposure to different environments, objects, and sounds helps puppies develop **adaptability** and reduce future fear responses — particularly important between **weeks 5 and 8**.
- **Note:** If a particular learning experience does not occur during the socialization period, it can still take place afterward, but will require **considerably more time**.
- Basic training *(sit, down, recall, toilet training, etc.)* conducted in a **positive and benevolent manner** using rewards presents no issue and can even **strengthen the human–dog bond** when experienced as enjoyable by both parties.
- Learning experiences during this period **leave lasting impressions** on the dog and will influence its adult behavior — including both positive and negative associations.

- An intense fear or a strongly negative association can become **permanently encoded** in the dog's brain, altering its temperament and subsequent adult behavior.
- Until approximately **8 weeks of age**, the puppy is primarily driven by **curiosity**; thereafter, an inversion occurs and the puppy becomes more prone to **fear of novel stimuli**.
- It is therefore essential to **avoid exposing the puppy to negative experiences** during this period.

10.1.5. Juvenile Period and Puberty *(12 weeks to 6 months)*

- **Increased exploration and curiosity:** Puppies become increasingly independent and explore their environment more actively. **Social play** between puppies grows more complex, reinforcing social skills and competitive behaviors such as chase games and strength contests.
- **Development of communication skills:** At this stage, puppies learn **communication signals** — including postures and vocalizations — both with other dogs and with humans; skills that will remain essential throughout their lives.

10.1.6. Adolescent Period *(6 to 18 months)*

- **Consolidation of hierarchy and socialization:** Young dogs frequently **test social boundaries**, exploring their hierarchical position with other dogs and household members — sometimes leading to **challenging behaviors**.
- **Puberty:** In dogs, puberty corresponds to the onset of **sexual maturation**, triggered by hormonal changes.
- **Behavioral changes:** Dogs begin to show interest in reproduction and exhibit **sexual behaviors**, such as mounting or territorial marking — important for adult social behavior.
- Adolescent dogs may also experience **more frequent conflicts**, as they have not yet fully mastered appropriate social behavior, and other dogs tend to be **less tolerant** of them.

Onset of puberty by size:

- **Small breeds:** 5 to 6 months
- **Medium breeds:** 7 to 10 months
- **Large and giant breeds:** 16 to 18 months

10.1.7. Adulthood *(18 months and older)*

The adult dog has completed its growth and has normally acquired all the learning experiences essential to its **emotional development** — its character and temperament are therefore stabilized.

- **Behavioral stability:** At adulthood, the dog's personality and behavior become **more stable**. However, continued social interactions and physical and mental activities remain essential for maintaining **well-being**.
- **Learning and adaptability:** Although adult dogs are **less receptive to new learning** than puppies, they can continue to acquire new skills and adapt to different environments and social contexts.

10.2. BEHAVIORAL DEVELOPMENT OF THE CAT

The behavioral development of the cat enables it to acquire all the foundations necessary for a **serene social life**. In cats, behavioral development is divided into **six periods**:

10.2.1. Prenatal Period

Corresponds to the **mother's gestation period**, during which fetuses can respond to various stimuli. The mother's living conditions during gestation can influence the **future stress sensitivity** of the kittens. Toward the end of this period, just prior to birth, kittens become sensitive to their **mother's stress levels**.

10.2.2. Neonatal Period *(0–10 days after birth)*

- Covers the period from birth to the **10th day of life** *(until eyelid opening)*.
- The eyes and ears of kittens are **not yet functional** — they are born both **deaf and blind**.
- During this period, the senses of **touch, smell, and taste** are predominantly engaged.
- The mother plays an **essential role**, providing warmth, nutrition, and stimulating elimination by licking the kitten's hindquarters.

Figure 41: Newborn kittens with closed eyes

10.2.3. Transition Period *(10th to 15th day of life)*

- **Vision and hearing develop** during this period; by its end, all sensory systems are fully functional.
- Orientation toward a sound source becomes effective by **day 15**.
- By **day 10**, the kitten is capable of supporting its own body weight; by **day 15**, it walks and begins to gradually explore its environment.
- The development of sensory organs and locomotion enables the kitten to **interact effectively** with its mother *(attachment)* and littermates, facilitating environmental imprinting and the initiation of exploratory behavior.
- The kitten is **more precocious** in its development than the puppy.
- **Primary or archaic reflexes** associated with nursing begin to disappear: the swallowing reflex comes under **voluntary control**, while the rooting and labial reflexes disappear. The **perineal reflex**, however, remains and must still be triggered by the mother during this period to enable elimination.

10.2.4. Socialization Period *(2nd to 8th week of life)* — also called the sensitive period

This period is critically important, as it is during this time that the kitten acquires the **fundamental behavioral and social foundations**.

- The kitten must become familiar with **its own species** *(through its mother and littermates)*, as well as with **humans, other species, and its environment**.
- It is therefore essential that kittens are exposed during this period to the **maximum number of stimuli** *(sounds, animals, objects, etc.)* to develop future adaptability.
-

A. Intraspecific Socialization

- The kitten learns its **feline species identity** through interactions with its mother and siblings, thereby discovering the codes of communication.
- A large, cohesive litter kept together for an extended period promotes **better socialization**. An orphaned kitten must be promptly introduced to other cats to imprint on its species.
- Kittens model their behavior on their mother through **observational learning** — she initiates exploratory behavior in particular.
- Inadequate behavioral development can lead to **subsequent behavioral disorders**. *(e.g., a poorly socialized cat may flee from or display aggression toward conspecifics)*

- Through **play-fighting** with its mother and siblings, the kitten also learns **self-control** *(not biting or scratching too hard)* and contextual adaptation — fostering **bite inhibition**, which is valuable in life with humans.

B. Interspecific Socialization

- Corresponds to the recognition of **"friendly species"**. This learning requires a **positive context** — such as receiving strokes or treats to associate humans with friendship, or playing with a dog.
- This socialization is **limited**: encountering a single dog is insufficient for the kitten to consider all dogs as "friendly."
- Contacts must be **positive** *(strokes, play, etc.)*, **repeated**, and conducted with **multiple individuals**.
- A poorly socialized cat may respond to unfamiliar species with **fear, aggression, or predatory behavior**.
- The kitten must encounter the **maximum number of humans** *(babies, children, adults, elderly)* and **animals** *(dogs, birds, rabbits, etc.)* in a positive context to assimilate them as "friendly."
- Adequate socialization allows a cat to **cohabit with a dog or rabbit** without risk, provided socialization to these species occurred early enough.

Once the socialization period has passed — **12 weeks in puppies, 8 weeks in kittens** — social learning becomes **considerably more difficult**, if not impossible, if not already initiated during this period.

Figure 42: Socialization period in kittens

10.2.5. Juvenile Period *(9 weeks to 4–6 months)*

A transitional period between the imprinting/familiarization phase and puberty. The kitten **consolidates and organizes** its acquired learning. Sexual behaviors emerge between **4 and 18 months**.

10.2.6. Puberty Period *(4–6 months to 18 months)*

- **Males** have a distinctive feature: **cornified penile spines**, which develop around **6–7 months of age**, marking the onset of puberty.
- In **females**, puberty appears around **6 months of age**. The female's behavior does not change except during **estrus**, and the odor of her urine appears to remain unchanged — at least to the human nose.
- This period also marks the **detachment phase** from the mother. Following the attachment essential for survival, the concept of **detachment** is equally important.

10.2.7. Adulthood *(18 to 24 months)*

During adulthood, the cat **redefines its social bonds** in accordance with the experiences it has accumulated throughout its development.

10.3. BEHAVIORAL DEVELOPMENT OF THE SHEEP

10.3.1. Prenatal Period

- **Stress during gestation** can affect the behavioral development of the lamb, influencing its stress reactivity and postnatal temperament. Lambs born to stressed ewes display **increased anxiety** and **reduced sociability**.
- **Maternal cortisol levels** during gestation can affect the lamb's stress response, influencing fear-related behaviors and temperament following birth.

10.3.2. Neonatal Period *(Birth to 2 weeks)*

- **Imprinting and maternal bonding:** Shortly after birth, the lamb develops a **close bond with its mother** by following her and recognizing her scent and vocalizations. This period is crucial for **social learning** and the establishment of following and maternal recognition behaviors.
- **Suckling reflex:** From birth, the lamb possesses a **suckling reflex** that enables it to feed on maternal milk. This behavior is reinforced by **maternal pheromones**, helping the lamb recognize its mother and locate the udder.

Figure 43: Newborn lamb with its mother

10.3.3. Socialization Period *(2 to 8 weeks)*

- **Play behaviors:** From a few weeks of age, the lamb begins to **play with other lambs,** a behavior essential for the development of social skills and the establishment of hierarchy. These play behaviors include **jumping, running, and mock fighting**.
- **Development of fear and flight responses:** This period is also marked by **heightened sensitivity to fear and flight stimuli** — adaptive behaviors for predator avoidance. Fear of novel stimuli, such as loud noises or unfamiliar objects, intensifies during this phase.

10.3.4. Juvenile Period *(8 weeks to 6 months)*

- **Increased independence:** As lambs grow, they become **progressively more independent** from their mother — moving more widely, exploring their environment, and interacting more extensively with other group members.
- **Development of feeding behaviors:** Lambs begin to **consume increasing amounts of grass** and imitate the feeding behaviors of adults, learning appropriate food sources and adapting their dietary preferences to their environment.

10.3.5. Adolescent Period *(6 months to 1 year)*

- **Establishment of social hierarchy:** Young sheep continue to develop social interactions, particularly through **competitive behaviors** aimed at establishing their rank within the group. Dominance and submission are expressed through specific postures and behaviors, such as **confrontations with other young sheep**.

- **Reproductive behaviors:** Toward the end of this period, sheep begin to display signs of **reproductive behavior** — such as interest in potential partners and courtship displays — driven by hormonal maturation.

10.3.6. Adulthood ***(1 year and older)***

- **Behavioral stability and gregarious behavior:** At adulthood, sheep are **highly social animals** and exhibit strong **gregarious behavior**, which helps maintain herd cohesion and provides **protection against predators**. This behavior is fundamental to group interactions and social structuring.
- **Learning and memory:** Adult sheep possess **good memory and learning capacities**, being capable of recognizing conspecifics and humans for **several years**. These capacities enable them to adapt to environmental changes and maintain **stable social bonds**.

11. COGNITIVE ETHOLOGY

Cognitive ethology is a branch of animal behavioral study that examines the **mental capacities and cognitive processes** of animals, focusing on how they perceive, memorize, and solve problems within their environment.

Unlike more traditional approaches to ethology — which focus primarily on observable behavior — cognitive ethology seeks to understand the **internal mechanisms underlying these behaviors**, such as learning, memory, and decision-making.

Cognitive skills refer to the capacities that enable an individual to know, learn, and understand things. These skills are also involved in the processes of **thinking and reasoning**, training the brain to think, learn, remember, reason, and pay attention. Cognitive skills may be defined as the characteristics that **make learning possible**.

They are primarily classified into **5 main types:**

1. Attention
2. Perception
3. Memory
4. Logic and Reasoning
5. Processing

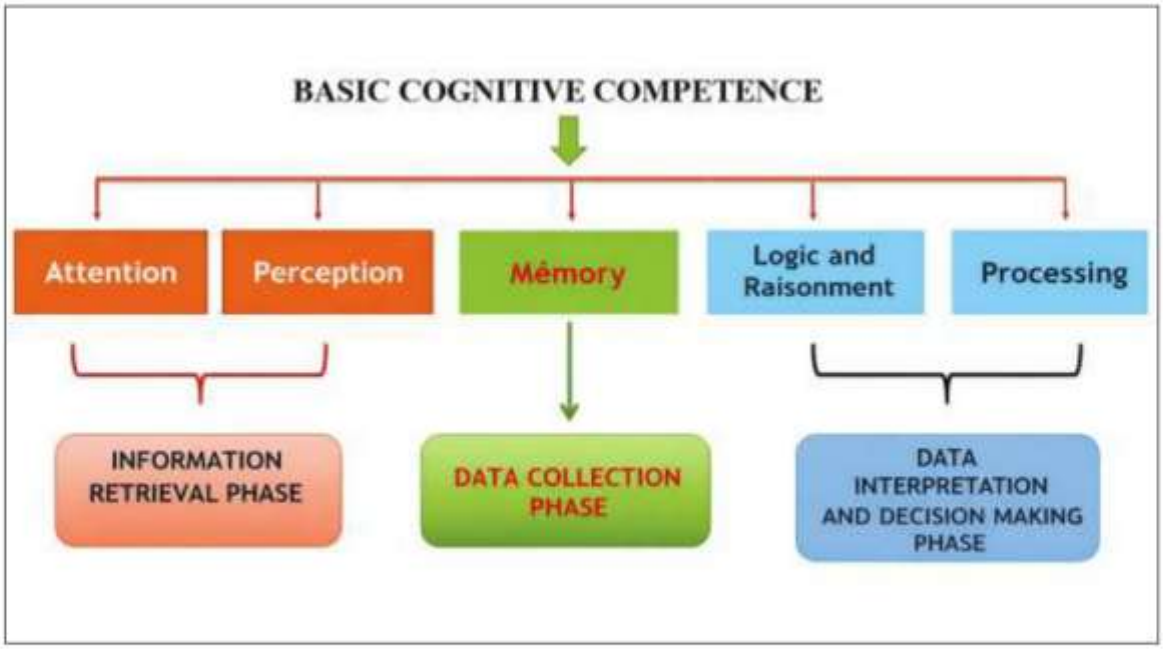


Figure 44: Cognitive skills applied during learning

11.1. BASIC COGNITIVE SKILLS

11.1.1. Attention

Attention is the process of **filtering incoming data from the sensory organs**. William James was the first psychologist to emphasize the importance of attention in behavior.

Attention is divided into **3 types:**

- **Focused attention:** The data to which an individual assigns the greatest importance during processing.
- **Sustained attention:** Data that must be processed **continuously over a prolonged period**.
- **Divided attention:** The individual must simultaneously process data from **multiple sources** to achieve a result.

11.1.2. Perception

Perception is the process of **interpreting what is perceived by the senses**. Sensations are captured through the sensory organs, which collect information about the environment.

Types of perception are classified according to the data generated by the sensory organs:

- **Visual perception:** The totality of data used by the brain derived from **what is seen** in the environment.
- **Auditory perception:** The totality of data used by the brain derived from **what is heard** in the environment.

- **Phonological awareness:** The ability to differentiate individual sounds within a group or community. *(e.g., a small wild animal recognizing its mother by a unique sound she emits, distinct from other sounds in the community).*

Processing speed: The time required to **transform data captured by the sensory organs into actions**. *(e.g., the sloth captures data rapidly but takes considerable time to process it; the Minke whale is among the mammals with the fastest processing speed)*

11.1.3. Memory

Memory is the process by which collected data is **conceptualized, stored, and processed**. Stored data is subsequently used as knowledge to inform future actions.

Memory is classified according to the **time required to store data:**

- ✓ **Sensory memory:** The shortest form of memory in terms of storage duration — corresponding to the interval between the moment a sensory organ captures data and the end of the stimulus. *(e.g., an animal locating its prey through its senses)*
- ✓ **Short-term memory:** The memory an individual uses at any given moment, typically lasting **a few seconds to a few minutes**. *(e.g., a dog has a memory span of approximately 2 minutes, during which it sorts useful information)*
- ✓ **Working memory:** Memory used by the individual **while performing an action**. *(e.g., an animal feeding while remaining vigilant to surrounding threats)*
- ✓ **Long-term memory:** Memory that is **stored permanently**. *(e.g., the image of a dove among turkey chicks)*
- ✓ **Visual memory:** Memory of **visual sensations** stored and retrieved at a later time. *(e.g., studies on crows indicate they are capable of recognizing human faces, recalling past events, and even learning through observation — behaviors indicative of advanced cognitive processes)*
- ✓ **Auditory memory:** Memory of signals received in **oral form**, stored for later use. *(e.g., a dog understanding a person's intended actions simply by hearing their words)*
- ✓ **Sequential memory:** Memory of the **order in which actions must be performed**. *(e.g., recent research has shown that certain animals — including chimpanzees, orangutans, rats, and moles — can order events in a specific sequence).*

11.1.4. Logic and Reasoning

Logic and reasoning is the process of **understanding the reasons and rationale** behind events.

Experiment: Greg Jensen of Columbia University tested macaques to study their **decision-making capacities**. His team discovered that these primates not only possess sequential memory, but can also **adapt their approach according to the situation**. However, scientists remain divided on whether animals truly possess the capacity to reason — while some animals have demonstrated the ability to apply logic in their decisions, researchers generally believe their choices are more closely based on **associative learning**.

11.1.5. Processing

Processing is the process by which **data is analyzed and utilized**. All animals compare the data they receive from their environment and apply it in their activities.

- **Tool use and problem-solving** represent another domain that highlights cognitive processes in animals.
- **Chimpanzees**, for example, use twigs to extract termites, while **dolphins** are known to use marine sponges to protect their rostrums when foraging on the ocean floor.
- This tool use demonstrates not only the ability to **adapt behavior to the environment**, but also **trial-and-error learning** and an understanding of **cause-and-effect relationships**.

11.2. SELF-AWARENESS

Studies on self-awareness also reveal important aspects of cognitive ethology. The ability of an animal to **recognize itself in a mirror** is frequently used as a test of self-awareness. **Great apes, certain elephants, and even some bird species** — such as magpies — pass this test, indicating a form of **self-consciousness**.

11.3. IMPORTANCE OF COGNITIVE SKILLS IN ANIMALS

Cognitive skills define an animal's **behavior, the complexity of community relationships, adaptability, and survival capacities**. They also determine how an animal **stores, processes, and applies information** in its actions.

- Animals use these skills to **remember food and water resources**, as well as the locations where these resources can be found according to climatic conditions.
- It has been observed that certain animals **migrate thousands of kilometers** in search of food and water or to escape hostile environments.

- Animals develop their cognitive skills in accordance with their **needs, climatic conditions, and threats** they face.
- Some animals also **select their sexual partners** using cognitive skills.

Animals display a **remarkable range of cognitive skills**. Each species possesses a unique set of these capacities, which differ from one species to another. Certain animals even possess skills that humans may have **lost over the course of evolution**.