Chapt. 51 – Behavioral Biology

Behavior = what an animal does and how it does it

Every behavior results from a combination of **genetic** ("**nature**") and **environmental** ("**nurture**") influences

A **species interaction** that nicely illustrates many aspects of animal behavior (reed warbler - cuckoo interaction)...

Instincts allow reed warblers to build nests and to lay eggs without learning how to do so
Even so, nesting behaviors only occur when the appropriate **environmental cues** are present, and they improve with **experience** (through **learning**)
Reed warbler chicks instinctively beg for food
Cuckoos instinctively parasitize reed warblers' nests
Cuckoo chicks instinctively remove reed warbler eggs
Cuckoo chicks instinctively exploit the innate feeding behavior of the reed warbler adult
Female cuckoo chicks become adults that instinctively parasitize reed warbler nests
The aforementioned, specific behaviors are instinctive adaptations that arose through evolution by natural selection
As such, each requires an **environmental context** and can be modified by **experience** and **learning**

Hybrid lovebirds provide another example of the dual nature of behavior (combining **genetic** and **environmental inputs**)…

Hybrid behavior has elements inherited from both parents, and can be modified by **experience** and **learning**

Every behavior has both **proximate** and **ultimate** causes

Proximate causes are the **environmental stimuli** that trigger a behavior, as well as the genetic and physiological mechanisms underlying that behavior

Ethology mainly concerns proximate causes

Three **ethologists** shared the Nobel Prize in 1973:
Karl von Frisch, Konrad Lorenz & Niko Tinbergen

Ultimate causes concern the evolutionary significance of a behavior; *i.e*., the balance between **fitness costs** and **benefits** that selectively favors the behavior

Behavioral ecology attempts to understand both **proximate** and **ultimate causes**

See textbook examples: Fig. 51.4 & 51.5

For the lovebird example presented in class:

Proximate cause: Daylength changes trigger the release of hormones that stimulate a nest-building response

Ultimate cause: The fitness benefits have outweighed the costs during the evolution of nest-building behavior

Innate behavior

Innate (**instinctive**) behaviors do not have to be learned; the animal performs them correctly with no prior experience

A simple kind of innate behavior is a **fixed action pattern** in response to an **external sensory stimulus** (a **sign stimulus**)

Human babies have an **innate dive reflex**

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

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

Male sticklebacks use simple cues to recognize other males **[Fig. 51.4]**

A red "belly" is the **sign stimulus**

An aggressive attack is the **fixed action pattern**

Tinbergen showed that variously shaped models could stimulate the response just as well as real males, supporting the sign-stimulus hypothesis **[Fig. 51.3]**

Tinbergen also showed that gull chicks beg in response to an appropriately colored dot

An appropriately colored dot is the **sign stimulus**

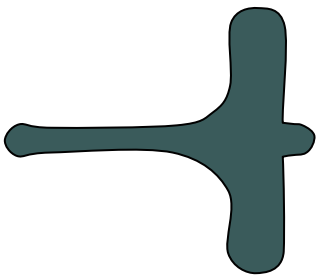
Begging is the **fixed action pattern**

Learning can modify **innate responses**

Resembles Goose (when traveling towards the left) -- Chicks ignore

Resembles Hawk (when traveling towards the right) -- Chicks crouch in fear

With repeated trials, chicks learn that neither shape is dangerous



Learned behavior

Learned behaviors are those that have been modified by **experience**

Habituation – loss of responsiveness to stimuli that convey little or no information

We quickly habituate to "background" noises
Habituation prevents an animal from wasting energy on unimportant stimuli

Imprinting – learning that is limited to a **sensitive period** in an animal's life
Lorenz's classic studies supported his imprinting hypothesis **[Fig. 51.5]**
Adults can also imprint on their offspring, so imprinting is not limited to juvenile stages
We humans have a **sensitive period** for learning **language**

Associative learning – the ability to associate one stimulus with another; includes several forms of **conditioning**

Classical conditioning – learning to associate an arbitrary stimulus with a reward or punishment
E.g., Ivan Pavlov's classic experiments

Operant conditioning (a.k.a. **trial-and-error learning**) – learning to associate one of an animal's own behaviors with a **reward** or **punishment**
We quickly learn to associate touching flames with a painful, burning sensation
Toads learn to avoid stinging insects through **one-trail learning**
Operant conditioning – the **Skinner box**
Both **positive** & **negative operant conditioning** can produce **learned behaviors**

Insight

Insight is demonstrated when an animal evaluates a new situation and performs the correct, **non-instinctive behavior** without prior experience
Insight is problem-solving without trail-and-error learning, so it relies on previous experience in contexts other than those that characterize the problem at hand

E.g., dog vs. chimp

Some adult ravens can figure out how to get meat hanging on a string the first time they are presented with this problem

Animal Cognition

Cognition, in the narrow sense, is synonymous with **consciousness** or **awareness**
Cognition, in a broader sense, is the ability of an animal to perceive, store, process, and use information gathered by **sensory receptors**
The extent of non-human cognitive abilities remains a hot, and important, topic of debate

Behavior serves many functions…

Foraging behavior comprises all of the means by which an animal searches for, recognizes, and manipulates food items

There are two main hypotheses for the ultimate reasons for **play**:

1. The **practice hypothesis** postulates that play allows animals to perfect behaviors needed later in life
2. The **exercise hypothesis** postulates that play helps muscular and cardiovascular systems develop properly

Movement through space

Kinesis – change in activity or turning rate in response to a stimulus **[Fig. 51.7]**
Sowbugs increase rates of travel in dry areas, which helps keep them in moist areas

Taxis – oriented movement toward or away from a stimulus **[Fig. 51.7]**
Sowbugs move away from light, which helps keep them in dark places

Dispersal (an animal behaviorist's definition) – one-time movement away from the **natal home range** **[Fig. 51.35]**

Tinbergen showed that wasps use simple **landmark** features to find their nests **[Fig. 51.14]**
In this example, female wasps may simply learn to look for a certain pattern of objects

A more complicated means of remembering information about locations involves **cognitive maps** – internal representations of the spatial relationships of objects in an animal's **home range**

Migration – relatively long-distance periodic movement (*e.g.*, annual)
Animals use one, or a combination, of the following to find their way:
Piloting – moving from one familiar landmark to the next
Orientation – an animal detects compass directions and moves in a straight-line path towards its destination
Navigation – an animal uses orientation combined with the ability to determine its present location relative to its target location

Social behavior

Interactions between or among individual animals of the same species

Behavioral ecologists attempt to determine the **adaptive significance** of **social behaviors** by elucidating their **fitness costs** and **benefits**

Mating systems – the costs and benefits of each potential mating system vary from species to species

Monogamy	♀ + ♂
Polygamy	
Polyandry	♀ + Multiple ♂♂
Polygyny	Multiple ♀♀ + ♂
Promiscuity	Multiple ♀♀ + Multiple ♂♂

Courtship – behavior patterns that precede **copulation** (or gamete release in species with external fertilization)

As in all behaviors, the balance of **benefits** and **costs** determines the direction of natural, or sexual, selection on **courtship behaviors**

One component of the male tungara frogs' courtship call is especially attractive to females
However, that component also attracts frog-eating bats!

Courtship often involves **rituals** – symbolic activities that help individuals assess the health, vigor, or status of other individuals

Rituals are also often employed in **intrasexual contests** for access to mates
If neither of two potential combatants "backs down" during a **ritual contest**, the contest may **escalate** to a potentially much more costly fight

Rituals are important means of defining and re-defining borders of **territories** (areas within an animal's **home range** that it defends against intruders)

Many animals live within **social groups**, and a **dominance hierarchy** ("**pecking order**") defines the **dominant** vs. **subordinate relationships** between each pair of individuals
Rituals help maintain the *status quo* **dominance hierarchy**, and combat is often required for the hierarchy to change

Solitary vs. **Group living**

Solitary
- Some benefits…
  - Decreased intraspecific competition
  - Decreased risk of disease
  - Decreased risk of detection by predators
- Some costs…
  - Decreased ability to cooperate in finding food
  - Decreased ability to cooperate against predators
  - Decreased likelihood of finding a mate

Group living
- Some benefits…
  - Increased ability to cooperate in finding food
  - Increased ability to cooperate against predators
  - Increased likelihood of finding a mate
- Some costs…
  - Increased intraspecific competition
  - Increased risk of disease
  - Increased risk of detection by predators

Eusociality – a special type of group living in which only one or a few members of the group ever reproduce

Non-reproductive members of **eusocial societies** sacrifice their own **individual fitness** to increase the fitness of others in the group, *i.e.*, they are **altruistic**

Eusociality challenged the paradigm that selection always favors behaviors that maximize **individual fitness**

W. D. Hamilton first suggested the solution to this apparent problem: **inclusive fitness**

Inclusive fitness – the total effect an individual has promoting the representation of its own genes in future generations, both by producing its own offspring and by providing aid that enables close relatives to produce offspring

Hamilton's Rule

Natural selection favors altruism if: **rB > C**

r = relatedness; B = benefits to recipient; C = costs to self

Natural selection that favors behaviors that enhance the reproductive success of relatives is called **kin selection**

The **coefficient of relatedness (r)** in **Hamilton's Rule** is the same as the probability that two organisms share a particular gene by direct descent **[Fig. 51.34]**

Female Belding's ground squirrels give alarm calls that are costly to themselves (exposure to predators), but that confer great benefits to their kin in the colony

Communication – an act performed by a **sender** that serves as a **signal** and produces a detectable change in the behavior of another individual (the **receiver**)

Communication can be **passive**

E.g., A female mandrill's colorful buttocks signal that she is fertile

Communication can be **active**

E.g. A male lion's roar can actively signal his presence

Communication can be **visual**

E.g. A male Anolis lizard's dewlap display can signal his quality

Communication can be **auditory**

E.g. A vervet monkey's warning call conveys information about the type of predator

Communication can be **olfactory/chemical**

Pheromones are the chemicals that animals use to communicate with one another

Communication can be **tactile**

E.g. Grooming and some aspects of courtship behavior are good examples

Honeybee communication combines many of these modalities

K. von Frisch first described the "**waggle dance**" of honey bees in the 1940s

Honey bees use pheromones, visual, auditory, and tactile signals to communicate information about the location of resources