Chapter 51: Animal Behavior

1. Stimulus & Response
2. Learned Behavior
3. Connecting Behavior to Survival & Reproduction
4 Questions relating to Behavior

The Dutch behavioral scientist Niko Tinbergen proposed approaching the study of animal behavior by asking 4 questions:

1. What stimulus elicits the behavior, and what physiological mechanisms mediate the response?

2. How does the animal’s experience during growth and development influence the response?

These 2 questions address the **Proximate Causation** of a behavior (i.e., **HOW** the behavior occurs and/or is modified).
The remaining 2 questions address the **Ultimate Causation** of a behavior (i.e., **WHY** the behavior occurs in terms of natural selection)

3. How does the behavior aid survival & reproduction?

4. What is the behavior’s evolutionary history?
1. **Stimulus and Response**
One of Tinbergen’s studies involved the response of male stickleback fish to a sensory stimulus – **RED**:

- male sticklebacks have red bellies and attack other males that invade their territories
- Tinbergen demonstrated that male sticklebacks respond aggressively simply to the color red (even a passing red truck!)

This unlearned response to a simple **sign stimulus** is an example of a **fixed action pattern** – an essentially an inborn and unchangeable behavior.
Migration is an Example of a Response to Sensory Cues

Birds, mammals, fish & other animals undergo regular migrations in response to a variety of sensory stimuli:

- seasonal changes
- position of the sun
- magnetic fields
- position of the North Star
Behavioral Rhythms

Migration, mating, hibernation, sleep and many other behaviors are influenced by circadian rhythms (as addressed in Chapter 40):

Circadian Rhythms

- rhythmic behavior linked to the cycle of a 24 hour day (e.g., sleep) in response to light and dark cycles

Circannual Rhythms

- rhythmic behavior linked to the cycle of the seasons

Lunar Rhythms

- rhythmic behavior linked to the cycle of the moon (which is correlated with tidal rhythms)
Animal Communication

Communication between animals involves a signal from one or more animals (i.e., a signal) that serves as a stimulus received by another animal. The nature of the signal can be:

**VISUAL**
- e.g., a “dance” or other display

**CHEMICAL**
- e.g., release of a pheromone

**AUDITORY**
- e.g., a “mating call”

**TACTILE**
- e.g., some sort of physical contact
Whatever the signal, once received it can then be the proximate cause of behavior in response to the signal.

This can lead to a series of behavioral stimuli and responses called a stimulus-response chain such as the mating behavior observed in fruit flies which involves all 4 types of stimuli:
“Dance Language” in Honeybees

In response to discovering a food source, a honeybee will “dance” in particular patterns upon returning to the hive to communicate multiple things regarding the location of the food source:

- the relative distance of the food source from the hive (i.e., near or far)
- the direction of the food source in relation to the sun
Chemical substances released for the purpose of communication are called pheromones.

For example:
An injured minnow releases a pheromone which stimulates other minnows to engage in protective behavior as if a predator is present.
2. Learned Behavior
Learning

Learning is a modification of behavior in response to experience which requires the formation of memories which is manifest in a variety of ways:

- Imprinting
- Spatial Learning
- Associative Learning
- Cognition & Problem Solving
- Social Learning
Imprinting

Some animals such as certain bird species exhibit a brief sensitive period early in life during which imprinting, a long-lasting behavioral response to an object, can occur:

- goose and crane hatchlings imprint their parents during a period of 1 or 2 days

imprinting can occur to the wrong species which has consequences for pair bonding in adulthood
Spatial learning involves the formation of memories relating to spatial structures in the environment.

• in this example shown by Tinbergen, the wasp has created memories of spatial landmarks pertaining the location of its nest.
Associative Learning

Associative learning involves “making connections” between experiences.

- in this example a blue jay has learned to associate a visual stimulus (the appearance of a monarch butterfly) with an unpleasant gustatory experience (bitter taste which induces vomiting):
Cognition is the process of “knowing” which involves awareness, reasoning, recollection and judgment which surprisingly is observed in insects such as bees:
Problem solving is a higher form of cognition which involves devising methods to proceed from one state to another in the face of one or more real or perceived obstacles.

- problem solving has been observed in mammals such as primates and birds such as ravens
Social Learning

Learning by observing the behavior of others is called social learning.

- For example, vervet monkeys learn from observing other vervet monkeys what alarm call to make in response to specific predators (e.g., eagle vs python).
3. Connecting Behavior to Survival & Reproduction
Behaviors That Enhance Survival & Reproduction

Many behaviors enhance survival and reproduction, however we will focus on two such behaviors:

**Foraging**
- finding, capturing and eating food

**Mating**
- mating behavior and mate choice
The optimal foraging model dictates that natural selection favors an ideal balance between risk (expending energy, predators) and reward:

- this experiment suggests that Northwestern Crows do in fact find the ideal balance between energy expenditure and the reward of obtaining food
Mating Strategies

Animal species exhibit a variety of mating strategies or mating systems – the length and number of relationships typical of the species:

**MONOGAMY**
- 1 male & 1 female pairing for an extended period of time

**POLYGyny**
- 1 male mating with multiple females

**POLYANDRY**
- 1 female mating with multiple males

Polygyny & Polyandry are both types of **POLYGAMY**.
Sexual Dimorphism in Relation to Mating Systems

In **MONOGAMY**, males & females tend to be very similar.

In **POLYGYNY**, the *males* tend to be highly ornamented.

In **POLYANDRY**, the *females* tend to be highly ornamented.
Genetic Basis of Behaviors

In *Drosophila*, two alleles for the *forager* (*for*) gene are associated with different foraging behaviors:

- the *for*\textsuperscript{R} allele is associated with more distant foraging and the *for*\textsuperscript{S} allele is associated with more local foraging

- in the lab, low population densities selected for the *for*\textsuperscript{S} allele and high population densities selected for the *for*\textsuperscript{R} allele
Prairie voles form strong bonds with their mates and exhibit caring behavior for their pups.

Meadow voles are more solitary and more or less ignore their pups.

- prairie voles express high levels of ADH (vasopressin) receptors in the CNS relative to meadow voles
- prairie voles given a drug that blocks ADH receptors behave like meadow voles
- meadow voles genetically modified to express more ADH receptors behave like prairie moles
Selection for Altruism

Altruism, helping others to the detriment of oneself, is observed in many species (e.g., humans, bees).

While decreasing an individual’s likelihood of survival and reproduction, altruism increases the likelihood of shared alleles being passed on through blood relatives.

- the closer the relation, the more alleles are in common
- e.g., siblings have ~50% shared alleles, nieces & nephews ~25%, and cousins ~12.5%
Hamilton’s Rule

William Hamilton has quantified the benefits of altruism with an equation called Hamilton’s rule:

$$rB > C$$

- $r$ = coefficient of relatedness (e.g., 0.5 for siblings)
- $B$ = benefit in terms of additional offspring from relative
- $C$ = cost in terms of fewer offspring from the altruist

If the number of additional offspring produced by a relative due to altruistic behavior multiplied by the degree of relatedness exceeds the loss of offspring from the altruist, the altruist’s alleles will increase in the next generation.