

# Biology Chapter 51: Behavioral Biology Outline

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## I. Behavioral Biology

- A. Behavioral knowledge has been studied for tens of thousands of years
  1. The first humans used knowledge of animal habits to catch meals and avoid predators
  2. Birds use songs to convey a variety of messages, including fertility, location, and territoriality
    - a. These songs are useful for biologists as a fairly easy way to determine the effect of communication on all biological levels
    - b. The study of bird songs has shown that both heredity and surroundings influence behavior
  3. Understanding behavior is required in order to explain the various interactions of a species
- B. Although most behavior consists of physical activity and muscular movement, nonmotor components are also a key part of behavior
  1. When a bird stores a song in its head, no physical response will be detected until much later, when the bird begins to imitate the song it has learned
  2. Thus, **behavior** encompasses both the actions of an animal and the methods used or needed to perform it
  3. Behavioral studies can be carried out on both an environmental and an evolutionary level
    - a. For example, a *proximate* explanation of certain birds' (such as the Magnolia Warbler) tendency to mate in the spring and summer seasons uses animal photoreceptors to stimulate neural and hormonal changes associated with reproduction behavior
    - b. An *ultimate* explanation, however, uses the fact that food is more plentiful in these seasons, and thus they are more advantageous times to reproduce
    - c. To summarize, proximate mechanisms eventually lead to behaviors that evolve because of a various advantage
- C. Behavior is affected by both heredity AND surroundings
  1. In biology, it is not debated over whether genes OR environmental factors contribute to a certain behavior, but rather how much either one affects the animal
  2. Behaviors can express different phenotypic variations, depending on the surroundings
    - a. Inbred lovebird caused a mix in habits and conventions of two different species of lovebird; as a result, unsuccessful or rather pointless behaviors developed and were further modified by the animal

3. All environmental factors affect the expression of genotypes
  - a. This includes chemical environment, whether on a cell or in an egg, and can affect all behaviors including interactions between various bodily systems
- D. Some behavior is largely genetic, with very little influence by environment
  1. *Innate* behavior does not reflect a broad range of environmental differences to change the behavior
    - a. An example of this is fledgling birds who (although blind) can still obtain food and open their mouths when they sense their parents
    - b. This is known as **developmentally fixed** behavior
  2. However, this innate behavior is never purely based on genes
    - a. Perhaps certain behaviors were so useful that all individuals in a species simply adopted them
- E. Ethology is the precursor to current behavioral biology
  1. **Ethologists** arose in the 1930s and some of the most famous ones, including Karl von Frisch (bees), Konrad Lorenz (geese), and Niko Tinbergen (wasps) were able to win a Nobel Prize for their study of animal behaviors in particular habitats
  2. These ethologists were largely concerned with innate and instinctive behavior, keeping in mind both proximate and ultimate elements
    - a. They formulated the concept of **fixed action pattern**, a group of behaviors that are more or less immutable and go to termination once started
      - i. These patterns are triggered by external stimuli known as **sign stimuli**
      - ii. Signals are often sent out by different species, esp. predators
    - b. One outstanding example of FAPs in animals is the stickleback fish, which utilizes its color vision to identify red-undersided males that try to invade its territory
      - i. Eventually, it was shown that the fish looked only for the color rather than any particular shape or scent
    - c. As a result of FAP studies, it was shown that many animals actually do NOT use their whole range of senses and have typical behavior
    - d. Modern behavioral ecologists consider FAPs too simplistic and some ethologists have thus hypothesized that these patterns improve time efficiency of animals and can apply to a variety of situations
    - e. For example, frogs rely on motion detection more than anything else to catch their prey
    - f. In summary, simple cues and stereotypical behavior often serve animals quite well

- F. Modern behavioral ecology concentrates on ultimate hypotheses
1. Animals utilize their genetic variation to express behaviors that optimize their fitness
    - a. Feeding behavior and mating behavior show this trend
  2. This approach that optimal behavior increases evolutionary fitness is termed **behavioral ecology**
  3. There are several examples of behavioral ecology research:
    - a. Many songbird songs sound similar but can be proven to be different
      - i. Males with larger song repertoires seem older and more experience to females and are thus chosen to mate more often
      - ii. Evolutionary principles are essential for research on behavioral ecology, for in the lack of them there is no *clear* alternative
    - b. Feeding relies on both genetics and surroundings
      - i. Animals feed in a variety of ways using different foraging behaviors linked to evolutionary traits
      - ii. Most animals can be classified as generalists, inefficient at catching one certain type of food, but having a variety of options, or specialists, who are extremely efficient foragers
      - iii. Generalists rely on a **search image**, a group of key characteristics that lead it to suitable food
        - 1) Search images lead to switching of food sources when they are not in abundance
      - iv. The phenomena observed during foraging have led to the concept of **optimal foraging**, which states that Darwinian selection favors animals that have efficient foraging methods
        - 1) Benefits range from total energy to specific nutrients
      - v. Optimal foraging involves a wide range of factors, including availability of food sources as well as food source value
      - vi. Behavioral ecologists attempt to predict how certain animals behave to try to forage optimally
      - vii. Bluegill sunfish are one example of animals who adjust their diet according to the distance of prey as well as concentration of prey
      - viii. Another example is the smallmouth bass that eats both minnows, which are harder to obtain but easier to eat, and crayfish, which are easier to catch but less nutritional

## II. Learning

- A. **Learning** is defined as the impact of certain experiences upon behavior
1. The majority of innate behaviors are improved greatly through experience

2. While a certain language itself must be learned completely, the ability to learn one is only possible in a complex brain
  3. Songbirds that have different songs can migrate and eventually adapt to another area by learning the songs of that region
  4. Specific songs help establish a specific group identity that can be used to identify friends and foes
- B. There are other way to affect innate behaviors
1. **Maturation** involves developmental changes in the neural and muscular systems of animals, when the body gains an ability such as flying
  2. Often, the difference between learning and maturation is not apparent
    - a. For example, a herring gull chick pecks the beak of an adult to induce regurgitation and obtain food; this behavior was eventually linked to learning and not maturation after laughing gulls responded more readily to foster feeders rather than actual parents
  3. Learning can also involve ignoring (not completely, however) stimuli that have little meaning; such learning is termed **habituation**
    - a. An example of this effect is the hydra, which will eventually ignore repeated contact (if harmless)
- C. Imprinting is another type of learning
1. Cases when innate behavior and learning work together very intricately are called **imprinting**
  2. In general, imprinting can only occur in a certain time period and is also immutable
  3. The ethologist Lorenz showed this phenomenon with incubated goose eggs, in which the hatchlings spent most of the beginning of their life with Lorenz instead of a true mother and later showed no recognition of other adults
  4. Imprinting depends on the presence of an outside *imprinting stimulus*
  5. The specific time period of imprinting is called the **critical period**, a limited phase in an animal's development
    - a. In the case of the geese, this period was the first few weeks of infancy
  6. A study of song learning in white-crowned sparrows shows that birds must both hear a certain song from an adult and then match the song by listening to itself; the absence of adult birds to provide the original song or a characteristic of deafness in birds caused songs to become distorted
    - a. This trend can be extended to humans as well: languages are most easily learned in the preteen and teenager years; although they can be learned later as well, the amount of time and effort is much greater
  7. Song sparrows and mockingbirds can learn songs from other birds as well

8. A study with canaries by Nottebohm showed that brain size varies with season and are largest when canaries require a large song repertoire to find a suitable mate
  9. The immense variety of song learning reflects its flexibility in birds
- D. Animals can also associate different stimuli
1. Classical studies dating back to the last century often dealt with **associative learning**, which involves connecting two different stimuli
  2. The most famous experiment involving this phenomenon was conducted by Ivan Pavlov, who induced drooling in dogs simply by ringing a bell (after using actual meat in the first trials); this type of associative learning is termed **classical conditioning**, and involves associating an arbitrary stimulus with either a reward or a punishment
  3. Trial and error learning in which an animal tests certain behaviors to test its consequences and then learning whether to continue that behavior is called **operant conditioning**
  4. The best example of operant conditioning was performed by Skinner, who induced manipulation of levers by rats after rewarding them with food
- E. Play actually has specific purposes
1. **Play** is generally defined as mammalian (and some bird) behavior that does not have a direct purposes but often involves behaviors associated with goals
  2. Often, play can be actually dangerous to animals when it results in seclusion of juvenile groups or excessive rowdiness or violence that can result in serious injuries
  3. As a result, play has been justified by a “practice hypothesis” that identifies play as a type of learning that allows animals to perfect behaviors without extreme consequences
  4. Another possible explanation is the “exercise hypothesis”, a less novel explanation that simply justifies play as a means for physical fitness

### III. Animal Cognition

- A. Cognition connects neurobiology and behavior
1. In general, the ability of an animal to take information and utilize it is defined as **cognition**
    - a. Thus, animal cognition has often been called **cognitive ethology** and seeks to show the relationship between data processing and behavior
  2. One type of cognitive ethology deals with physical stimuli in animal brains
- B. The importance of spatial representation
1. Much of cognitive ethology is based on a theory that animals create codes of the objects in their environment called **cognitive maps**
  2. Only simple animals could possess absolutely no type of cognitive map at all
    - a. Two types of movement that do not require the aforementioned cognitive maps are **kinesis**, induced changes

in rates of chemical or behavioral activity, and **taxis**, an automatic movement either in the direction of or away from another stimulus

3. The greatest example of cognitive maps is **migration**
  - a. Migrating animals have three techniques or methods that are most often used to identify their final destination
    - i. *Piloting* involves the identification of landmarks
    - ii. *Orientation* involves the sensing of compass direction
    - iii. *Navigation* is the most used and most complex of the three processes, and involves detection of an environment in comparison to other locations
  - b. These hypotheses are confirmed through case studies in starling birds, which reflect the more organized migration of experienced birds when compared with juveniles and transported birds
  - c. The range of cues used for navigation includes the magnetic field, the sun, and the stars (as well as other heavenly bodies)
  - d. As expected, the position of the cue rather than that actual cue itself has a more profound impact on navigation, and thus is more often the focus of cognitive ethologists
  - e. The Savannah sparrow is an example of a migrant that keeps a sort of “internal clock” when migrating that keeps track of magnetic and celestial locations and recalibrates itself when migrating

#### C. Awareness

1. Consciousness is a very difficult hypothesis to test in animals, and scientists often have difficulty in dealing with this question
  - a. Donald Griffin, a leader in this field, suggests that consciousness plays an important role in many animal behaviors, especially the “play-dead” tactic used by many prey to escape predators
  - b. Most researchers, nonetheless, believe that animals are NOT aware; this is caused by the fact that there is no real intermediate position in the debate, and that no biologist would declare that every animal exhibited consciousness
  - c. As a final note, the answers to the question of consciousness could have a very deep impact upon the way we view ourselves

### IV. Sociobiology

#### A. Social behavior and evolution

1. **Social behavior** has a very simple definition that involves any interaction between two animals
2. Social interaction are often an emphasis for any behavioral biologist because of the complexity of behavior during specific situations such as territoriality, mating, and predating or avoiding predators
3. The use of evolution as an explanation for social behavior is known as **sociobiology**

4. The leader of this field is William Hamilton, who used the ideas of fitness and genetically caused behavior to explain certain social behaviors
5. All social behavior is done for an individual benefit, even when cooperation is required and a group of animals seems to be obtaining a common benefit

#### B. Competitive social behavior

1. The first time of competitive social behavior is **agonistic behavior**, which involves contests over resources
2. As shown by rattlesnakes, much of agonistic behavior is simply **ritual**, symbolic activity that signifies intent but causes no actual harm
3. Although ritual behavior is also shown by many more species, especially dogs and wolves, many animals still engage in actual physical conflict and inflict injury on each other, at which point natural selection causes frequent ends to battles as soon as possible to prevent deaths
4. Agonistic behavior causes “social hierarchies” to developed in some animals, especially chickens
5. The establishment of this pecking order of animals including alpha, beta, and omega animals is called a **dominance hierarchy** and results in a wealth of advantages for a top-ranked animal
6. This hierarchy can also be observed in wolves, who hunt in packs but are led by a top female who consumes most of the food herself
7. Territoriality involves defending a certain **territory**, the are that an animal chooses to claim as its own to protect from other animals
8. There is a difference between territory and home range, as the former is outright defended with a physical tendency; however, home ranges are not very clearly marked and are much larger
9. Owners usually maintain control of their territory due to their improved knowledge of their environment
10. Territoriality is not always favored by natural selection, but it is nonetheless a very common trend that is continually exhibited and usually only at true threats
11. Dominance hierarchies and territoriality play a vital role in maintaining population densities and stability of animal populations

#### C. Mating behavior

1. Most animals are not aware of the importance of reproduction, nor do they share the same romantic attraction as humans often do
2. Because of the distrust among members of the same species, regardless of gender, complex courtship interactions must occur before mating
3. The time and resources required to produce an offspring is termed the **parental investment**
4. Because eggs are usually more costly to produce than sperm, females seem to have a higher parental investment
5. In many species, competition among males is the greatest factor in determining mates; this results in *sexual selection*

6. However, sometimes the female selects from the males is a process known as *assessment*
7. In cases where male sperm is their only parental investment, males display themselves in n are known as a **lek**, from which females select a suitable mate
8. Female assessment is hard to predict or justify, but in insects it appears to be largely based off of rituals, such as in dance flies
9. There are different types of mating relationships:
  - a. **Promiscuous** relationships have no lasting relationships
  - b. **Monogamous** relationships involve one of each partner
  - c. **Polygamous** relationships involve one partner mating with several
  - d. **Polygyny** refers to the polygamous relationship that involves one male and several females
  - e. The opposite of polygyny (one female) is **polyandry**
10. A final factor in mating systems is certainty of paternity
  - a. Sometimes it is difficult to identify the correct father because of multiple partners
  - b. For this reason, very few bird or mammal species have male **ONLY** parental care

#### D. Diverse Communication

1. *Displays* are transmissions of information that relates to social interactions and mating behaviors
2. Communication is two-way; there must be a response for a display to be considered communication
  - a. Bird songs induce responses and are thus communication
3. Deceit is also present between species
  - a. Sometimes, dominant males will kill offspring that do not belong to them
4. Chemical signals can be used by animals as communication; they emit odors and are called **pheromones**
  - a. Bees are another good example of animals (esp. insects) that utilize pheromones to communicate

#### E. Altruism

1. **Altruism** is defined as reducing individual fitness to increase that of another individual, the one who receives the behavior
  - a. Two main examples of altruism are the Belding squirrel and bees, which warn other members of the species when danger approaches
2. To justify altruism, sociobiologists developed the concept of **inclusive fitness**, which discusses the effects of an individual on its own offspring and other close relatives as well
3. Inclusive fitness can be measured by the **coefficient of relatedness**, which is a ratio of identical genes in common ancestors
4. An individual's altruism can result in more identical genes if it aids a sibling as opposed to a cousin; this is known as **kin selection**

#### F. Sociobiology and Human Culture

1. Many birds and mammals avoid incest as human have learned to do
2. Sociobiologists discuss the question of whether avoiding incest is another innate behavior or one learned through socialization
3. Some sociobiologists link cultural and genetic components so that they reinforce each other
  - a. Opponents of these scientists' views fear that their interpretation of human behavior could justify injustices and prevent change
  - b. Sociobiology cannot account for everything, and perhaps social and cultural practices make the human species unique from the rest