Lecture 19: Animal Behavior

I. Background

A. Animal behavior reflects and arises from biological properties
1. Exhibited behavior defends on the physiological systems and processes unique to a given organism
2. Behavior is an action carried out by muscles under control of the nervous system in response to a stimulus
3. Behavior is purposeful
   a. Acquiring nutrients for digestion
   b. Finding a partner for sexual reproduction
   c. Defense
4. Behavior contributes to homeostasis
   a. Many body variables must be maintained within narrow ranges
      i. Body temperature for example
   b. Behavior may contribute to this process
      i. Ectotherms may bask on a warm rock or hide in a burrow
5. Behavior reflects the collective of all physiological systems
   a. Only behaviors permitted by an animal’s physiological systems are possible
   b. Behaviors often then affect the physiological systems from which they emerge
6. Behavior at a primal level promotes survival and reproduction; therefore, behavior was subject to selective pressure during evolution
7. Behavior requires communication among individual members of a population
   a. Selective pressures have acted on the anatomical and physiological systems to promote elements that permit the recognition and communication required for behaviors

B. Discrete (specific) sensory inputs elicit behavior
1. To understand behavior:
   a. Identify the specific stimulus that elicits the behavior
   b. Determine what physiological mechanisms mediate the response
   c. Identify events and experiences during growth and development that influence the emergence of the behavioral response
   d. Contribution that the behavior make to survival and reproduction
   e. Identify evolutionary events that have shaped the development of the behavior
2. Must be processes that permit a behavior to occur
3. Must be an adaptive purpose for the behavior shaped by natural selection

II. Types of behaviors that are elicited in response to simple stimuli

A. Fixed action patterns--FAP
1. Sequence of unlearned behavioral acts directly linked to a simple stimulus
   a. Sign stimulus
      i. External stimulus triggering the behavior
2. FAP are unchangeable and are usually carried to completion once initiated
B. Migration
1. Regular, long-distance change in location
2. Environmental stimuli act to trigger the behavior and also provide cues that animals use to carry out the behaviors
3. Mechanisms and environmental cues are species specific
   a. Not completely understood

C. Circadian, circannual, and lunar behavioral rhythms
1. Circadian rhythms is a brain-based pattern that synchronizes bodily functions with light and dark cycles
2. Circannual rhythms are linked to yearly seasonal cycles
   a. Behavioral rhythms such as migration and reproduction are circannual rhythms
   b. Typically correlate with food availability
      i. Not a direct response to changes in food intake
   c. Directly influenced by the periods of daylight and darkness in the environment
      i. Food availability is generally correlated with these periods
3. Lunar behavioral rhythms
   a. Many marine species are affected by tidal patterns
   b. Tides result from lunar cycles
   c. Behaviors linked to tidal patterns are lunar behavioral rhythms

III. Communication between animals

A. Stimuli that elicit behavior may be generated by other animals
1. Signal
   a. Stimulus transmitted from one animal to another
2. Animal communication is the transmission and reception of signals

B. Stimulus response chain
1. Complex series of behaviors where each response serves as the stimulus for the next behavior
2. Fruit fly courtship
   a. Male identifies a female of the same species based on visual and chemical communication
      i. Visual recognition of the female by appearance (Visual communication)
      ii. Olfactory cues provided by the female are detected by the male’s olfactory system (Olfactory communication)
   b. Male approaches and taps the female with a foreleg (Tactile communication)
      i. Contact transfer other chemical signals present on the female
      ii. Confirms species identity
   c. Male extends and vibrates his wing--specific courtship song (Auditory communication)
      i. Confirms that the male is the same species
   d. Female then permits copulation

C. Animals employ symbolic information (language) to communicate
1. Honeybees use a symbolic language to share information about the location of food sources
2. Specific behaviors that provide information
3. Behaviors associated with foraging
   a. Round dance
      i. Returning bee displays moves in tight circles while waggling its abdomen from side to side
      ii. Symbolically means food is within 50m (i.e., nearby)
      iii. Behavior motivates follower bees to leave the hive and search for food that is nearby
   b. Waggle dance
      i. Returning bee moves in a half-circle swing in one direction, a straight run, and a half-circle swing in the other direction
      ii. Symbolically means food is farther away
      iii. Angle of the straight run relative to the hive’s vertical surface is the same as the horizontal angle of the food in relation to the sun
      iv. Dance with a longer straight run indicates a greater distance to the food source
      v. Follower bees exit the hive, they fly almost directly to the area indicated by the waggle dance

D. Pheromones
   1. Chemical substances that animals use to communicate
      a. Common among mammals and insects and often relate to reproductive behavior
   2. Moth pheromones released by a female moth
      a. Can attract a mate from several kilometers away
      b. Trigger specific courtship behaviors
   3. In a honeybee colony, pheromones produced by the queen and the workers maintain the hive’s complex social order
   4. Fish release pheromones in response to environmental circumstance
      a. Pheromone serves as alarm signal
      b. Nearby fish become more vigilant and form tightly packed schools

IV. Contribution of learning to behavior

A. Innate behavior
   1. All individuals in a population exhibit virtually the same behavior
      a. Not affected by internal and environmental differences during development and throughout life

B. Some behaviors that are affected experience
   1. An animal’s specific experiences during growth and development influence the response to stimuli

C. Imprinting
   1. Long-lasting behavioral response to a specific individual or object
   2. Occurs only during a specific stage of life
      a. Limited to a sensitive period or critical period
      b. Only time when a particular behavior can be learned
   3. Includes both learning and innate components
   4. Young imprint on their parent and learn the basic behaviors of their species
   5. Parent learns to recognize its offspring
The tendency to respond is innate
   a. The imprinting stimulus is provided by the environment
   b. Waterfowl have no innate recognition of “mother”
      i. Respond to and identify with the first object they encounter that has certain key characteristics

D. Spatial learning
1. Natural environment shows spatial variation in the locations of nest sites, hazards, food, and prospective mates
2. An organism’s fitness may be enhanced by its capacity for spatial learning, establishing a memory that reflects the environment’s spatial structure

E. Cognitive maps
1. Neural representation of the spatial relationships between objects in an animal’s surroundings

V. Types of learning
A. Nonassociative
1. Habituation
   a. Learning to learn to ignore a stimulus that lacks meaning
2. Sensitization
   a. Intensification of a response to a given stimulus

B. Associative learning
1. Types
   a. Classical conditioning
   b. Operant conditioning

C. Classical condition
1. Learned association between two or more stimuli
2. Requires temporal pairing
3. Types of stimuli
   a. Unconditioned stimulus (UCS)
      i. Evokes a response (UCR)
   b. Conditioned stimulus (CS)
      i. Does not evoke a response
      ii. Pairing with UCS will come to illicit a response (CR)
   c. Conditioned response (CR)
      i. May be similar or UCR or may differ
   d. An association is learned between the UCS and the CS

D. Instrumental (operant) conditioning
1. Learned association between a behavioral act and its consequence
2. Consequence is generally that presentation or withdrawal of a stimulus
3. Types of stimuli
   a. Appetitive
   b. Aversive
Positive contingencies
a. Behavior results in the delivery of a stimulus
   i. Appetitive stimuli increase the probability of the behavior occurring
   ii. Positive reinforcement
b. Aversive stimuli decrease the probability of the behavior occurring
   i. Punishment

Negative contingencies
a. Behavior results in the removal of a stimulus
b. Absence of the appetitive stimuli decreases the probability of the behavior occurring
   i. Omission
c. Absence of the aversive stimuli increases the probability of the behavior occurring
   i. Negative reinforcement

VI. Complex behaviors

A. Cognition and problem solving
1. Many complex forms of learning involve cognition
   a. Process of knowing represented by awareness, reasoning, recollection, and judgment

B. Problem-solving behavior is highly developed in primates and dolphins
1. Problem solving is the cognitive activity of devising a method to proceed from one state to another
   a. Progression may involve obstacles and require choices

C. Acquisition of some types of behavior may be learned in distinct stages
1. Sensitive period
   a. Specific developmental times when a particular behavior must be established
2. Complex behaviors are acquired sequentially
   a. Behaviors to be acquired later require other behaviors to be established first
   b. Failure to establish primary behavior precludes the development and/or changes the characteristics of behaviors that emerge later in life

D. Social learning
1. Many animals can learn to solve problems by observing the behavior of other individuals
2. Innate behaviors are not sufficient
3. Specific behaviors may have arisen through novel applications of innate capacities
   a. These behaviors, practiced and modeled by some individuals, are the copied by others
4. Most human behavior results from social learning

E. Mating systems and extent of parental care
1. Mating behavior includes seeking and attracting mates, choosing among potential mates, and competing for mates
2. Mating relationship between males and females varies a great deal from species to species
3. Types of pair bonding
   a. Promiscuity
      i. Mating in the absence of bonds
   b. Monogamy
      i. One male and one female bonded
   c. Polygamy
      i. One individual mating with several partners, each with multiple partners
   d. Polygyny
      i. One male bonded with many females
      ii. Males are generally dimorphic, with males being larger with more conspicuous traits
   e. Polyandry
      i. One female bonded with many males
      ii. Females are more ornamented and larger than males

4. Sexual dimorphism
   a. In polygynous species, males are generally larger with more conspicuous traits
   b. In polyandrous species, females are more ornamented and larger than males

5. Mating systems depend on the needs of the young
   a. Young that cannot care for themselves and require a large, continuous food supply
      i. Greater than a single parent can provide
      ii. Reproductive success requires the male
      iii. Requires monogamy
   b. Birds that can feed themselves from birth
      i. Less need for parents to stay together
      ii. Males of these species can maximize their reproductive success by seeking other mates
      iii. Polygyny is common in such birds
   c. In mammals, the lactating female is often the only food source for the young
      i. Males provide no parental care in most mammal species
      ii. In some mammals, males protect many females and their young

6. Certainty of paternity
   a. Can males be certain that the offspring are genetically his?
   b. Without reproductive certainty, male parental investment is likely to be lower
   c. Females can be sure that they contributed to an offspring when they give birth or lay eggs
   d. Males lack paternity assurance in species with internal fertilization
      i. Acts of mating and birth are separated over time
      ii. Exclusively male parental care is rare in birds and mammals
      iii. Males in many species with internal fertilization engage in behaviors that increase their certainty of paternity
   e. Certainty of paternity is much higher in species that engage in external fertilization
      i. Egg laying and mating occur together
      ii. Parental care in aquatic invertebrates, fishes, and amphibians, when it occurs, is as likely to be by males as females
F. **Sexual selection**
   
   1. Form of natural selection in which differences in reproductive success among individuals are a consequence of differences in mating success
   
   2. Forms
      
      a. Intersexual selection
         
         i. One sex choose mates on the basis of particular characteristics of the other sex
         
         ii. Courtship songs
      
      b. Intrasexual selection
         
         i. Competition among members of one sex for mates
   
   3. Mate preferences by females may play a central role in the evolution of male behavior and anatomy through intersexual selection
      
      a. Traits favored by females occur at greater frequencies in subsequent generations
      
      b. Examples
         
         i. Eye stalk lengths
         
         ii. Bright colored feathers
      
      c. Traits may reflect general health and therefore likely to produce more offspring that survive to reproduce

G. **Behavioral strategies in mating**
   
   1. Game theory
      
      a. Evaluates alternative strategies in situations where the outcome depends on the strategies of all individuals involved
   
   2. Behavior exhibited depends on relative performance, not absolute performance
      
      a. Outcomes in some circumstances may select against a particular individual to benefit the reproductive success of the species

**VII. Experience can modify genetic programs that underlie behaviors**

A. Complex behaviors require multiple genes, often at different loci

B. Master regulatory genes
   
   1. A single gene may direct the expression and activity of other genes
      
      a. Controlled genes have more narrow functions
      
      b. Master regulatory gene has a more dynamic function
   
C. Specific experiences and interactions with the environment can affect the expression of master regulatory genes
   
   a. Complex behaviors are therefore affected this differential expression