Chapter 51: Animal Behavior

AP Biology
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1

Behavior

- Behavior - the nervous system's response to a stimulus and is carried out by the muscular system or the hormonal system
- Behavior is subject to natural selection
- Four questions that must be answered:
  - What stimulus elicits the behavior, and what physiological mechanisms mediate the response?
  - How does the animal's experience during growth and development influence the response?
  - What is the evolutionary history of the behavior?
  - How does the behavior contribute to survival and reproduction (fitness)?
- Behavioral ecology - study of the ecological and evolutionary basis for animal behavior

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Proximate vs. Ultimate causes of behavior

- Proximate questions = "How" questions
  - Environmental stimuli that trigger a behavior
  - Genetic, physiological, and anatomical mechanisms underlying a behavioral act
- Ultimate questions = "Why" questions
  - address the evolutionary significance of a behavior

3

Fixed Action Pattern (FAP)

- Fixed Action Pattern (FAP) - sequence of unlearned behavioral acts that is essentially unchangeable and, once initiated, is usually carried out to completion
- Triggered by an external sensory stimulus, a **SIGN STIMULUS**
- Classic example of a FAP is the stickleback fish

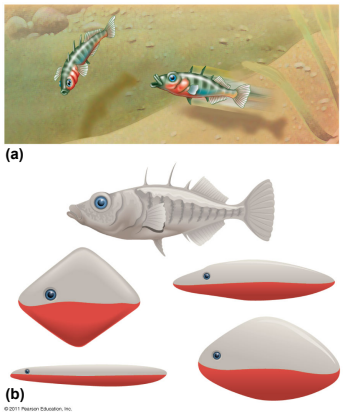

Fig. 51.2

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Migration

- Environmental cues can trigger movement in a particular direction
- Migration - regular, long-distance change in location
- Complex process but seems to be genetically based
- Animals orient themselves using the position of the sun, circadian clock, position of the North Star, and Earth's magnetic field
- Blackcap - small warbler
  - Range: Cape Verde Islands off West Africa to northern Europe
  - Migratory Blackcaps that are caged hop restlessly in cages during migration times
  - Cape Verde birds do not migrate
  - When migratory and nonmigratory birds were mated and placed in both locations, 40% of offspring showed migratory restlessness.

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Behavioral Rhythms

- Some behavior is affected by circadian rhythm (daily cycle of rest and activity)
- Behaviors like migration and reproduction are linked to changing seasons (circannual rhythm)
- Daylight and darkness are common seasonal cues
- Some behaviors are linked to lunar cycles, which affect tidal movements

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Animal Signals and Communication

- Signal - behavior that causes a change in another animal's behavior
- Communication - transmission of, reception of, and response to signals
- Many signals are energy efficient
  - Territorial fish will erect their fins providing them with a larger profile which runs off intruders
- Signals can be visual, auditory, chemical, tactile, and electric

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Animal Communication: Fruit Fly Courtship

- Male identifies a female of the same species and orients toward her
  - Chemical communication: he smells a female's chemicals in the air
  - Visual communication: he sees the female and orients his body toward hers
- Male alerts the female to his presence
  - Tactile communication: he taps the female with a foreleg
  - Chemical communication: he chemically confirms the female's identity
- Male produces a courtship song to inform the female
  - Auditory communication: he extends and vibrates his wings

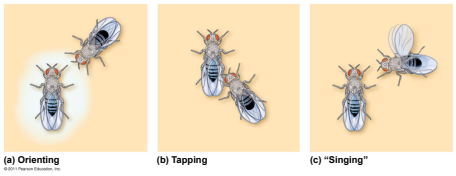

Fig. 51.4

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Animal Communication: Honeybees

- Show symbolic language
- Bee returning from the field performs a dance to communicate information about the distance and direction of a food source

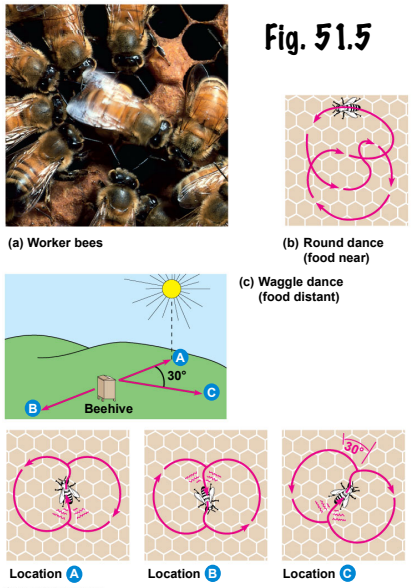

Fig. 51.5

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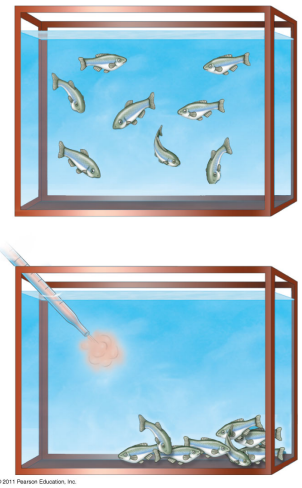
Chemical Communication

* Pheromones - chemical emitted by an animal for olfactory communication
  * Reproductive behaviors
  * Alarm behaviors



(a) Minnows before alarm

(b) Minnows after alarm

Fig. 51.6

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Learning

* Innate behavior - developmentally fixed and does not vary among individuals
* Cross-fostering study places the young from one species in the care of adults from another species
  * ex. cross-fostered mice developed some behaviors consistent with foster parents
* Twin studies - compare influences of genetics and environment on behavior

* Learning - modification of behavior based on specific experiences

Table 51.1 Influence of Cross-Fostering on Male Mice*

Species	Aggression Toward an Intruder	Aggression in Neutral Situation	Paternal Behavior
California mice fostered by white-footed mice	Reduced	No difference	Reduced
White-footed mice fostered by California mice	No difference	Increased	No difference

*Comparisons are with mice raised by parents of their own species.

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Imprinting

Fig. 51.7

* Imprinting - includes both learning and innate components and is generally irreversible
* Sensitive period - limited phase in an animal's development that is the only time when certain behaviors can be learned
* Parent-offspring bonding critical part of life cycle in species that provide parental care
* Geese studied by Konrad Lorenz in the 1930s
* Whooping Cranes, if hatched by sandhill cranes, will imprint and never form a mating pair

(a) Konrad Lorenz and geese

(b) Pilot and cranes

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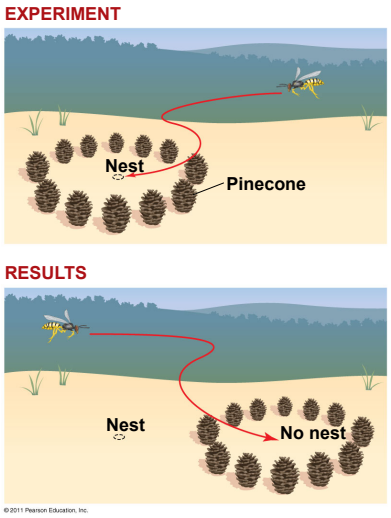
Spatial Learning

Fig. 51.8

- Modification of a behavior based on experience within the spacial structure of the environment
  - Ex. nesting sites, hazards, food, mating
- Digger wasps using landmarks
  - Using landmarks involves learning



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Cognitive Maps

- Internal representation, or code, of the spacial relationships between objects in an animal's surroundings
  - Ex. covids (birds like ravens, crows, and jays) may store food in many locations and can even keep track of food quality

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Associative Learning

- Association of one feature of the environment with another
- Classical conditioning - an arbitrary stimulus (like a scent) is associated with a reward or punishment (electric shock)
- Operant Conditioning - trial-and-error
  - Learning to associate one of its own behaviors with a reward or punishment

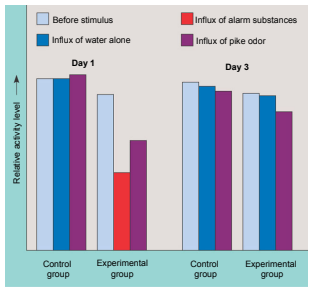

Figure 51.16

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Cognition

- the ability of an animal's nervous system to perceive, store, process, and use information gathered by sensory receptors
- Cognitive ethology - examines the connection between an animal's nervous system and its behavior
- Problem solving behaviors

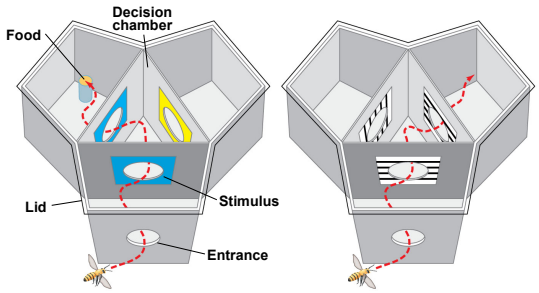

Fig. 50.10 (Honeybees distinguish "same" vs. "different")

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Social Learning

- Social Learning - learning through observing others
- Culture - system of information transfer through social learning or teaching that influences the behavior of individuals in a population

Figs. 51.11 & 51.12

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- Foraging - behavior associated with recognizing, searching for, capturing, and consuming food
- <u>Drosophila melanogaster</u> has a foraging gene called for
  - for^{s} - "sitter" larva moving less than average
  - for^{R} - "rover" larva moving more than average
  - Average frequencies are 70% for^{R} and 30% for^{s}
  - After 74 generations there was a clear divergence between low and high density populations
  - for^{s} increased in frequency in low density
  - for^{R} increased in high density populations

Foraging Behavior

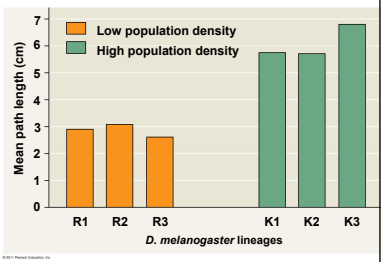

Fig. 51.13

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Optimal Foraging Model

- Views foraging behavior as a compromise between benefits of nutrition and costs of obtaining food
  - Costs: energy expenditure and risk of being eaten
  - Natural selection should favor foraging behavior that minimizes the costs and maximizes the benefits
  - Ex. Northwestern crow - crow drops a mollusc from a height to break its shell and feed on the soft parts (crow trade-off between height dropped and number of times it must drop it)

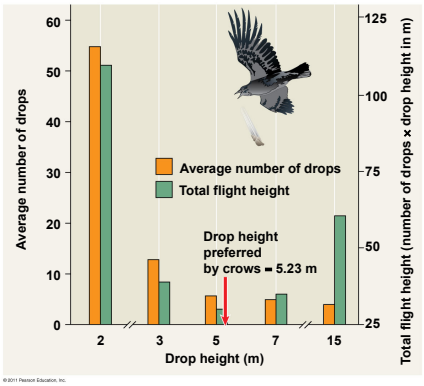

Fig. 51.14

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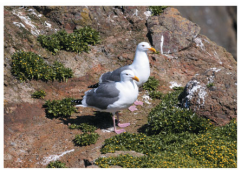
Mating Behavior

- Promiscuous - no strong pairing bonds or lasting relationships
- Monogamous - mates remain together for a longer period (mates tend to look very similar)
- Polygamous - individual of one sex mating with several of the other (usually dimorphic)
  - polygyny - one male and many females (males ornamented and larger)
  - polyandry - one female and many males (females ornamented and larger)



(a) Monogamous species

(b) Polygynous species

(c) Polyandrous species

Fig. 51.15

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Sexual Selection and Mate Choice

- Differences in reproductive success among individuals are a consequence of differences in mating success
- Sexual dimorphism results from sexual selection (form of natural selection)
- Intersexual selection - members of one sex choose mates on the basis of certain traits
- Intrasexual selection involved competition between members of the same sex for mates

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Mate Choice by Females

- Zebra finches
  - Researchers taped red feathers to foreheads of both parents, males only, or females only before their chicks opened their eyes
  - When the chicks matured, they were given a choice of mates with or without ornamented feathers
    - Males showed no preference
    - Females raised by non-ornamented parents or only female ornamented parents showed no preference
    - Females raised by both ornamented parents or only male ornamented parents showed a preference for ornamented mates
    - Shows that females imprint on their fathers

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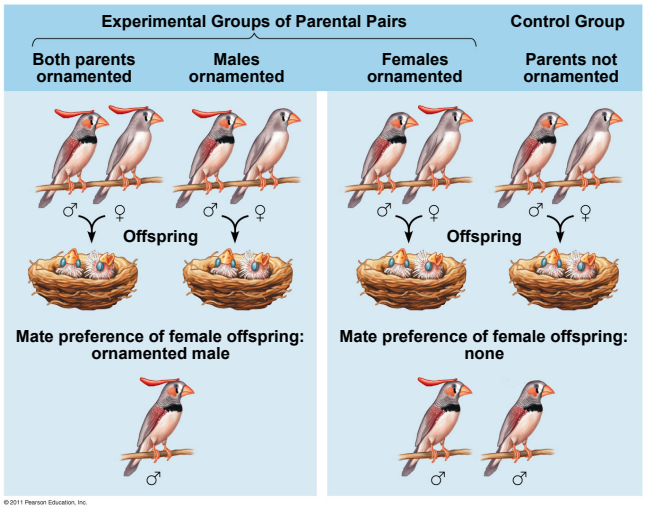
Zebra Finches

Fig. 51.19



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Mate Choice by Females

- Stalk-eyed flies
  - Females are more likely to mate with male with longer eyestalks
  - Why?
    - Behavioral ecologists correlated genetic disorders with short eyestalks
    - Healthy male increases probability of healthy offspring

Fig. 51.17

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Mate Choice Copying

* individuals in a population copy the mate choices of others

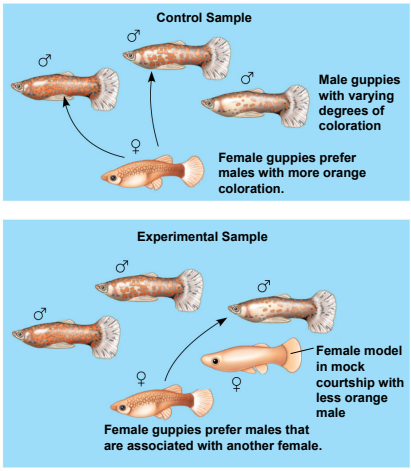

Fig. 51.20

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Male Competition for Mates

* This can reduce variation among males
* Agonistic behavior - ritualized contest that determines which competitor gains access to a resource such as food or mates

Fig. 51.21

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Game Theory

* Evaluates alternative strategies in situations where outcomes depend not only on strategy but also on strategies of others
* Side-blotched lizards
  * Orange-throats - most aggressive and defend large territories with many females
  * Blue-throats - territorial but defend smaller territories with fewer females
  * Yellow-throats - non-territorial males that mimic females to obtain matings

Fig. 51.22

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Mating and Parenting

- Prairie Voles
  - Monogamous (rare trait in mammals)
  - Both parents provide care for young (also very rare)
  - Grooming and cuddling behaviors with mate (also rare)
- Thought that the cause of these behaviors was arginine-vasopressin (AVP), a nine amino acid neurotransmitter released during mating
- AVP binds with a receptor called the V_{1a} receptor
- Found differences between distribution of V_{1a} receptors in the brains of prairie voles versus promiscuous montane voles

Fig. 51.24

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Behavioral Traits and Natural Selection

- Natural Selection can result in evolution of behavioral traits in a population
- Prey selection in garter snakes (Thamnophis elegans)
- In California, coastal populations eat salamanders, frogs, and toads, but predominantly slugs. Inland populations eat fogs, leeches, and fish, but not slugs.
- When inland snakes were offered slugs, they refused to eat them even when the snakes were born in captivity.

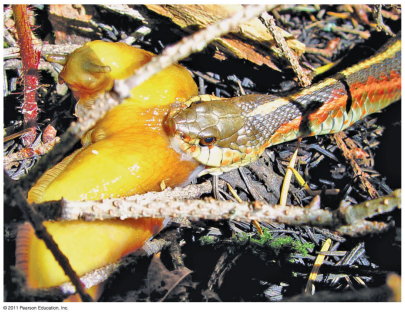

Fig. 51.25

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Blackcaps

- Breed in Germany and winter in Africa (some winter in Britain)
- In laboratory conditions, each migratory population exhibits different migratory behaviors
- Migratory behaviors are regulated by genetics

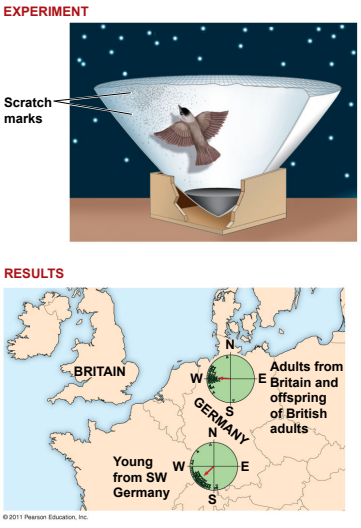

Fig. 51.26

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Altruism

- Natural selection favors behavior that maximizes an individual's survival and reproduction
- Altruism - behaviors that reduce an individual's fitness but increase the fitness of others in the population
- Inclusive fitness - total effect an individual has on proliferating its genes by producing its own offspring and providing aid that enables close relatives to produce offspring
- Ground Squirrel
  - Gives off a high-pitched alarm call when it sees a predator. The others run to safety, but it puts the initial squirrel at more risk
- Naked Mole Rats

Fig. 51.27

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Hamilton's Rule

- Measure for predicting when natural selection favors altruistic acts
- Natural selection favors altruism when rB>C
- Variables:
  - B = benefit to recipient (average number of extra offspring the beneficiary produces)
  - C = cost to altruist (how many fewer offspring the altruist produces)
  - r = coefficient of relatedness (probability that the two individuals share a common parent or ancestor or particular genes will be common)

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Hamilton's Rule

- Example: Two brothers, close in age, equally fertile, not yet parents. One is close to drowning and his brother risks his life to save him.
  - Average person in U.S. has 2 offspring. If he had drowned his reproductive output would have been 0. Thus, B = 2
  - In the surf the altruistic brother was swimming there was a 5% chance of drowning. The cost is then 5% of his offspring or C = 0.1
  - Because they are not identical twins, but are brothers, there is a 50% chance they will share a particular gene. Thus, r = 0.5

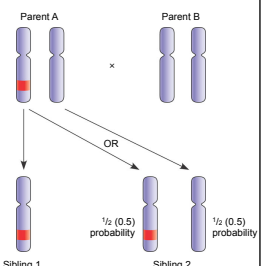

Figure 51.34

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Kin Selection

- natural selection that favors altruistic behavior by enhancing reproductive success of relatives
- Weakens with hereditary distance
  - non-identical siblings, r = 0.5
  - uncle and niece, r = 0.25
  - first cousins, r = 0.125
- Would it benefit a swimmer to rescue his cousin?
  - rB>C; rB = 0.125 x 2 = 0.25; C = 0.1
  - Yes, it is still favored
  - If the rescuer is a poor swimmer and has a 50% chance of drowning instead of 5%. Then 0.5 x 2 = 1 which is greater than 0.25, so it would not be favored.

Kin Selection in Ground Squirrels

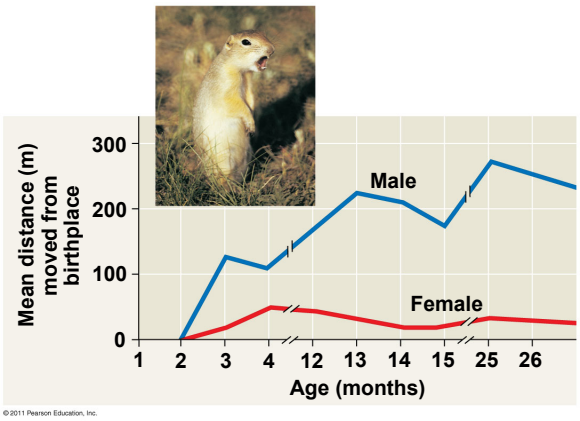

Fig. 51.29

Reciprocal Altruism

- behaving altruistically toward others who are not relatives to gain favors in the future
- Rare in animals and usually only seen in species who have stable social groups
- Tit-for-tat strategy
- In these groups, cheaters (those who do not reciprocate are punished

Genetics vs. Environment

- All behaviors are a combination of genetics and environmental factors
- Innate behavior - developmentally fixed that have strong genetic components
- Directed Movements
  - Kinesis
  - Taxis
  - Migration

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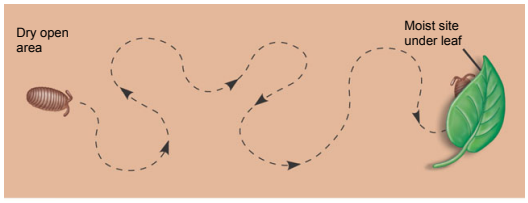
Kinesis

- Simple change in activity or turning rate in response to a stimulus
- Sow bugs (wood lice) - terrestrial crustaceans
  - Kinetic response to humidity



(a) Kinesis increases the chance that a sow bug will encounter and stay in a moist environment.

Figure 51.7a

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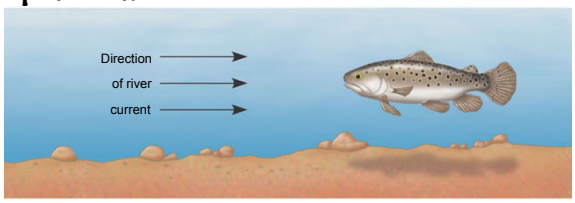
Taxis

- Automatic (more or less), oriented movement toward (positive taxis) or away from (negative taxis) some stimulus
- Trout
  - Swim to orient themselves toward current (upstream)



(b) Positive rheotaxis keeps trout facing into the current, the direction from which most food comes.

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Habituation

- Loss of responsiveness to stimuli that convey little or no information
  - Ex. A hydra contracts when disturbed by a slight touch; if it is repeatedly disturbed without further consequences, it stops responding.
  - Ex. "cry-wolf" effect
  - How does this increase a species' fitness?

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Alarm Calls

- Vervet Monkeys
  - Complex set of alarm calls distinct to different dangers (leopards, eagles, snakes)
  - Infants start off generalizing (will give eagle call when they see any bird)
  - Eventually learn from adults to use specific cues

Figure 51.37

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Human Culture

- Sociobiology
  - Main premise: certain behavioral characteristics exist because they are expressions of genes that have been perpetuated by natural selection

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