Environmental Effects on Behavior

1. How does the environment affect behavior?
2. How is the development of behavior affected by the environment?
3. Are the effects adaptive?
4. How can learning affect behavior?

Phenotypic Plasticity

1. Phenotypic plasticity: the ability of a genotype to produce different phenotypes in different environments.
2. There is a range in plasticity.
   a. Canalized: Traits do not vary much in different environments.
   b. Plastic: The trait can vary greatly in different environments.
3. Plasticity measured by exposing particular genotypes to different environments and observing if there are different phenotypes.

Innate Behaviors (Instinct)

1. NO learning involved with innate behaviors
2. Environmental cue required, but there is no change in the behavioral phenotype (canalized).
3. Two ways to recognize:
   a. Performed perfectly the first time that the appropriate stimulus is encountered.
   b. Performed to completion even if the stimulus is removed.

Innate Behaviors (Instinct)

Three components
1. Sign stimulus – stimulus that releases innate behavior. A particularly relevant stimulus that is innately recognized
2. Innate releasing mechanism – neural path involved in responding to the stimulus (very vague, not well understood)
3. Fixed action pattern – pre-programmed behavior or set of behaviors in response to the stimulus (the behavioral outcome)
Examples of Innate Behaviors

1. Gull Begging Behavior (Tinbergen).
   a. Red dot on gulls bill = Sign stimulus
   b. Chick’s nervous system = Innate releasing mechanism.
   c. Begging behavior (peck the red dot to get food) = Fixed action pattern

Tests
   a. Cardboard cutout of gull head with red dot = 100% response
   b. Cutout with just bill and red dot = 92%
   c. Full head, no red dot = 35%
   d. Red pencil with white stripes = 126% response

Examples of Innate Behaviors (Instinct)

2. Egg retrieval behavior in geese (Tinbergen and Lorenz)
   a. Remove egg from nest, put .5 meters away, goose stretches neck, tucks egg under bill, rolls egg back into nest.
   b. Replace egg with egg sized object, goose does egg retrieval response.
   c. Remove object as it is being retrieved, goose continues pulling its head back as if it had an egg.

Yawning as a releaser

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The Development of Worker Behavior in Honey Bees

Colony consists of three types of bees: Queen (2N), Workers (sterile females, 2N), Males (N).

1. Worker bees divide up labor in the colony.
   a. Cleaning nursery cells
   b. Feeding juveniles
   c. Cache and distribute honey to workers
   d. Foragers
   e. Scout (new sources of food)

2. Workers go through all 5 tasks sequentially.

Hormonal Causes of Worker Behavior

1. Age related transitions are regulated, in part, by juvenile hormone (JH).

2. Young workers have low concentrations of JH, older foragers have higher concentrations.

3. Young bees treated with JH become precocious foragers.

4. Foraging behavior is delayed if the glands that produce JH are removed from a worker.

Social Causes of Worker Behavior

1. Is worker behavior only determined by age?
   Experiment: Colonies made with workers of all the same age.
   Result: There is still division of labor. Some become foragers sooner, some stay nurses longer.

2. Do social encounters influence transitions in worker behavior?
   Experiment: Added older foragers to colonies of only young workers.
   Result: As more older bees are added, fewer young workers undergo an early transformation.

3. Conclusion: Worker behavior is plastic. It changes depending on the social environment

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**Developmental Plasticity**

1. Developmental phenotypic plasticity – permanent changes to morphology and/or physiology

   - Polyphenism: a single genome produces two or more alternative phenotypes in response to an environmental cue. Alternative forms are markedly distinct.
   - Polymorphism: genetic variation results in different forms.

**Examples of Polyphenism**

![Examples of Polyphenism](image)

**Polyphenic development in spadefoot toad tadpoles (genus Spea)**

- Genetically similar tadpoles
- Did tadpole ingest shrimp early in life?
  - No → Tadpole develops into an "omnivore" morph
  - Yes → Tadpole develops into a "carnivore" morph

**Foraging behavior and development interact**

**Environmental Effects on Behavior**

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**Cannibalism in Tiger Salamanders**

**Two forms of Tiger Salamanders**

1. Small form eats pond invertebrates.
2. Large form feeds on other tiger salamander larvae.
3. Cannibals only develop when many salamanders live together.

**Presence of Kin affects Cannibal Development**

from Pfennig and Collins, 1993

<table>
<thead>
<tr>
<th>Composition of population</th>
<th>Cannibals Develop</th>
<th>No Cannibals Develop</th>
<th>Experiments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Siblings only</td>
<td>31 (40%)</td>
<td>46 (60%)</td>
<td>77</td>
</tr>
<tr>
<td>Non-siblings present</td>
<td>67 (84%)</td>
<td>12 (16%)</td>
<td>79</td>
</tr>
</tbody>
</table>

Presence of kin reduces change of cannibals developing. This is adaptive. Natural selection favors those that do not eat their relatives.

**Environmental Effects on Behavior**

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Learning

1. Learning: A relatively permanent change in behavior as a result of experience
2. Hunger is an example of an impermanent behavioral change due to experience. Not learning.
3. Learning involves some kind of memory, even if it is not cognitive.
4. Types of learning: Habituation, sensitization, classical conditioning, instrumental conditioning, cultural

Habituation

1. Habituation – repeated exposure to a stimulus results in a decrease in behavioral response to the stimulus. Downgraded response
2. Sea slugs – researchers gently poked its siphon and it pulls in its gill. After repeated pokes it stops retreating its gill.
3. Highly adaptive for stimulus filtering
   a. Prey animal – must filter out all movements that aren’t the predator (grasses, clouds, etc.) Once habituated to these it can better detect different movements
   b. Predator animal – filter out objects that aren’t prey (cryptic prey can evolve as a response)

Sensitization

1. Sensitization – repeated exposure to a stimulus produces a heightened response
2. Sea slugs – researchers shock the slug and gently poked its siphon. It pull in its gill much faster. Withdrawal behavior remains enhanced for an hour.
3. It could be adaptive to have a heightened response to repeated exposure to things that are dangerous.
   Ex: Flee faster from things that hurt you in the past.

Associative Learning

1. Associative Learning – An external event gets associated with internal state and/or a change in the animal’s behavior.
2. One step removed from a single, primary stimulus
3. Types: Classical conditioning
   Operant conditioning
Classical (Pavlovian) Conditioning

1. Example: Pavlov’s Dogs
2. Sensitized by ringing a bell
3. Animal is able to predict significant events by environmental cues
   a. Significant event – unconditional stimulus
      Ex: food → uncontrolled salivation (not learned)
   b. Environmental cue – conditional stimulus
      Ex: bell → salivation

Operant Conditioning

1. Operant (instrumental) Conditioning – animal learns to associate a voluntary action with the consequences of performing it (a reward or punishment).
2. Example: A Skinner Box. Rat pushes a lever, food pellet drops out.
3. In the wild this is important for foraging and escape.
   a. Example: Trial and error learning in frogs. If a tree frog eats a noxious beetle, it will avoid it on sight thereafter.

Skinner Box
Cultural Learning

1. Culture – a system of information transfer that affects the individual’s phenotype
2. Part of an individual’s phenotype is acquired from others by teaching or social learning.
3. Cultural transfer can occur without transfer of genes.
4. Meme – a unit of cultural inheritance that’s similar to the gene (R. Dawkins)

Cultural Evolution

1. Culture can be passed on vertically (parents to offspring) or horizontally (between any individuals in a group).
2. Culture differs from other learning because cultural influences are passed from individual to individual.
   a. Individual learning: individual dies, info lost
   b. Cultural learning: what is learned by one individual can be passed on through endless generations.
3. Cultures can evolve! There is variation, heritability, and differential fitness.
4. Cultural evolution can happen very quickly (a few generations for culture, thousands for genetic evolution). Do to ease of information transfer.

Examples of Cultural Learning/Evolution

1. Food washing in macaques
   a. Imo the macaque washed sand from sweet potatoes, others copied.
   b. Imo tossed sandy wheat in water, sand sank, wheat floated, others copied behavior

Examples of Cultural Learning/Evolution

2. Chimps learn how to fish for termites by watching others. Not all chimp tribes have this behavior; have different cultures.
Examples of Cultural Learning/Evolution

3. Blue tits learned to open milk bottles. Probably the result of copying.

![Blue tits and milk bottles]

Examples of Cultural Learning/Evolution

4. Mother cheetahs facilitate/teach hunting skills in their offspring.
   a. Knock down prey, but let it run off when cubs arrive.
   b. Carry live animals back to cubs.
   c. Sometimes run slowly and allow cubs to overtake prey first.

![Educating Cheetah]

Extended Example: Bird Song Learning

1. Example: Bird Song Learning (Peter Marler)
2. White-crowned Sparrows – different regional dialects (Marin and Berkeley)
3. Several possibilities for difference in song
   a. Genetic differentiation
   b. Is it cultural? Is song more like a meme?

![White-crowned Sparrow]

White-crowned sparrows and Social Learning

Test 1
1. Took eggs from both populations and raised them in lab (no social influences!)
2. At ~50 days young males made twittering song, only vaguely like the adult’s song.
3. As they grew up, they kept singing but never developed the full song.
4. This shows there has to be a social component.
White-crowned sparrows and Social Learning

Test 2
1. Reared birds with the tape recorded song of either Marin or Berkeley (randomized)
2. These birds sang whatever song they were exposed to perfectly
3. Differences in dialect was not genetic, but instead cultural/memetic.

White-crowned sparrows and Social Learning

Test 3
1. Took young WC sparrows and played Song Sparrow song. (Song Sparrow is a different, yet closely related, species to WC sparrow)
2. Young birds developed an aberrant song that resembled the song of birds that had not heard a song.
3. Even though highly memetic, there is a genetic component that constrains the songs they can learn.
4. If played both a Song Sparrow song and a White-crowned Sparrow song, they always chose to learn species-specific song (their own species song).

White-crowned sparrows and Social Learning

Test 4
1. Exposed bird to a song during its critical period (10-50 days of age), then deafened it.
2. Deafened birds could not develop the proper song.
3. At 150 days, males produce a subsong and try to match their own vocal output to their memory. They needed to hear themselves sing.

White-crowned sparrows and Social Learning

Summary
1. Regional dialects are cultural and plastic.
2. Learning is needed: needed to learn song from other birds; needed to learn how the song sounds as it was practiced.
3. Learning the species specific song is canalized (probably due to natural selection).