Learning Goals

- 4 types of intelligent behavior traits
- Explain why intelligence varies among species (using CDEF)

---

<table>
<thead>
<tr>
<th>Keyword</th>
<th>Behavior Continuum</th>
<th>Environmental Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1 Learned intelligence</td>
<td>Flexible (ability to learn is heritable)</td>
<td>Short-term change: predictability in the lifetime of individuals</td>
</tr>
<tr>
<td>2.2 Culture</td>
<td>Intermediate pre-adaptation to learn socially</td>
<td>Intermediate: on a time scale of generations</td>
</tr>
<tr>
<td>2.3 Inherited instinct</td>
<td>Fixed (stimulus/response is heritable)</td>
<td>Long-term change: predictability on a geologic time scale</td>
</tr>
</tbody>
</table>

Halliday (1994) is vague on concepts, lets elaborate to distinguish between the scientific perspective and folk psychology of intelligence.

We need to distinguish clearly between 2 ends of a continuum. On one end is learning, on the other end is instinct. In Folk Psychology terms, learning is “intellec” and instinct is “intuition”. Learned behavior is not passed on genetically, instinct is. In between (on the continuum) is social transmission, where the ability to learn from social companions is heritable.

These are 3 distinct concepts associated with adapting to changing worlds- often confused in Folk Psychology- need to be clearly distinguished in Science Q2.1

Intuitive warm up- some examples of how flexibility of behavior varies among species, related to how much the environment has changed in past history of each species

Pbr_func.avi SOURCE: The Brain: Discovery

(View Video Clip 1)
Q2.1 people use many "yardsticks" to measure intelligence; here are a few; lets start with an example of learning that you may relate to...

How is intelligence measured?

**Proximate: 4 "yardsticks" used to measure intelligence:**

- **Learning** (e.g. urban foxes Halliday 1994:135)
- **Problem-solving** (e.g. blue tits open milk bottles pg137; macaques learned from Imo to wash potatoes pg.136)
- **Communication** (e.g. bright guppy males attract females pg 139; song dialect of chaffinches pg. 135)
- **Awareness** (e.g. mirror test in primates not in Halliday or Dugatkin)


Why does intelligence vary across species?

...... why have fish, reptiles, birds and mammals diverged during evolution of this trait (TIP: compare brain anatomy)?

Pcortevo.avi SOURCE: The Brain

(View Video Clip 6)

Why? Comparative brain anatomy

Relative size of cortex (memory) compared to whole brain

- **Smallest cortex- e.g. fish**
  - aquatic environment is relatively predictable
  - simple learning tasks; wakefulness
- **Medium cortex- e.g. reptile**
  - transition from water to land; cold-blooded
  - emotions are the basis for more complex motivation
- **Largest cortex- e.g. long-lived birds & mammals**
  - H1: complexities of staying warm
  - H2: Predator/prey "arms race"
  - H3: Social intelligence in navigating group living

Intellect

The cortex is where learning takes place, where new stimuli are associated with behaviors, where new behaviors are shaped. Less learning takes place in the brains of animals with less cortex. In general, ethologists think of species with less cortex as belonging on the “instinctive” end of the continuum of adaptation. Those with more cortex are more toward the “intelligent” end of the continuum.

Where would you place dogs on this continuum?
To fully understand how animals think differently than humans, we need to know more about the internal mechanisms of learning.

Learning occurs in the brain cortex (outer layer of grey matter). This is where associations are reinforced. The genes control the shape of the cortex and number of possible neuron connections. View Video Clip 4

The learned associations (stimuli, reward and response) are based on connections between neurons.

- Repetition- strengthened connections between neurons
- Lack of use- weakened connections (pruning)

FP: intuition based on emotions

Science Perspective (SP): all vertebrates share the "reptile brain", which provides the basic mechanisms for learning.

This is our take home message. To gauge your learning progress, ask yourself the question “have I discovered the clues to answer Q2.1 and Q2.2”?
Learning mechanisms: clicker training?

As you listen to this video clip, think about what Gary Priest says is similar about learning in people and other animals. What are the steps you would use to start the clicker training process with an animal you know?

Bridging:
- click stimulus
- give food reward
- repeat until animal looks for food at the click
- Click stimulus means food reward
- We know learning occurred when the animal looks for the reward when it hears the click, this is a learned change in its behavior.

Learning happens as a result of what happens in the environment of the animal...ethologists call this the “external stimulus”. We have identified two types used in training procedures.

We call the clicker a “bridging stimulus”

We call the pole a “target stimulus” (a lazer pointer may also be used as a target stimulus, e.g. when the trainer is outside the animal’s cage)

How do we know the learning occurred? The response changed.

The second step is Targetting
- present target stimulus
- click when the animal is close to target
- Give food reward
- repeat until animal touches target
- Target stimulus means food reward

Think how you would use this to train a tiger to move between cages. Share your ideas.
Learning happens as a result of what happens in the environment of the animal...ethologists call this the “external stimulus”. We have identified two types used in training procedures.

We call the clicker a “bridging stimulus”

We call the pole a “target stimulus” (a lazer pointer may also be used as a target stimulus, e.g. when the trainer is outside the animal’s cage)

How do we know the learning occurred? The response changed.

Q2.2

Concept map: Learning - adaptation to short-term change

- **C**: ability to change behavior, based on rewards & punishments associated with a stimulus;
  - includes: learning, communication, problem-solving, awareness
  - “bridging” and “targeting”

- **D**: individual vary due to diverse experiences during each lifetime, heritable ability to learn
  - more “nurture” than “nature”
  - “learning to learn” results from a rich early environment

- **F**: (H1) “ice ages” - genotypes with more flexible learning abilities survived global climate change
  - (H2) predator/prey “arms race” - those that learned to overcome prey defenses got more food

- **E**: (H3) divergent:
  - species with relatively larger cortex (memory) have greater ability to learn
  - (H4) Inertia: ancestral “reptile brain” is in all vertebrate species; basic ability to learn

Q2.2

Let’s use this information about learning to illustrate the four perspectives in ethology (CDEF).

In folk psychology, intellect is the ability to learn about changes in the immediate environment of an individual. Intelligent individuals learn, stupid individuals do not.

There are two hypotheses about the function of why this might have evolved. One hypothesis is related to natural selection during the harsh conditions of the ice ages. Another hypothesis is related to the “arm’s race” in coevolution of smart predators and their prey.

Learning Goals

- 4 types of intelligent behavior traits
- Explain why intelligence varies among species

Discussion Questions to prepare for Final Exam

Q2.1 From a proximate perspective, what are four types of intelligent behavior in animals? (TIP: PC-give example for each)

Q2.2 Why does intelligent behavior differ among species? (TIP: UE-relate ability to learn with change in environment; state specific examples)
Questions….want more elaboration?

Could you explain what you mean by instinct & learning?

Let’s Review Learning

- How? each learned response changes in the lifetime of an individual
- Why? ability to learn changes in the gene-pool of each species over a geologic timescale

Let's repeat the video clip we saw at the beginning of this presentation, to reinforce in your minds how learned behavior is an adaptation to those aspects of the environments that change within a lifetime. The ability to learn is a heritable trait that ethologists hypothesize has changed during evolutionary history, associated with changes in brain anatomy.

Pbr_func.avi SOURCE: The Brain: Discovery

(View Video Clip 1)
Contrast flexible learning with fixed instinct

C: instinct is an intuitive, reflexive action that consistently occurs in response to a given stimulus, in all individuals
- effective the first time it occurs,
- learning is not necessary (or minimal)
- little reflection or thinking involved

D: instinct is highly heritable; even though individuals are raised in diverse environments, the behavior is the same
(FP: “nature” not “nurture”)

F: function of instinct: those genotypes that responded immediately to stimuli that reliably predicted danger, were more likely to have survived

FP: if you thought twice when a cheetah was running after you … you would have been “dead meat”

E: instincts are more similar in species that have more similar gene pools

H1: “reptile brain” illustrates phylogenetic inertia over the long-term
H2: as species with more cortex diverged, they were more flexible in response to short-term environmental changes

In Folk Psychology terms, we often hear “intelligence is not instinct”. Behaviors change due to intelligence. Instinctive behaviors do not change. The individual does not learn, because the response is encoded in the “blueprint of the genes”. We will get back to this in the last presentation of this unit.

FP: intuition

To fully understand how animals think differently than humans, we need to know more about the internal mechanisms of learning.

Learning occurs in the brain cortex (outer layer of grey matter). This is where associations are reinforced. The genes control the shape of the cortex and number of possible neuron connections

- The learned associations (stimuli, reward and response) are based on connections between neurons.
- Repetition- strengthened connections between neurons
- Lack of use- weakened connections (pruning)

View Video Clip 5

What is the difference between problem-solving, communication and awareness; aren’t these all learning?
PC: Problem-solving

C: actions combined in new ways to achieve a goal not previously experienced
D: more likely in juveniles than adults; ability to learn novel responses is moderately heritable
E: convergent- in each taxon, species with more complex/thick brain cortex are better at problem-solving
F: those that could solve novel problems were more fit when there were changes in the environment

CDEF: Problem-solving

PC: Communication

Clip 7
SOURCE:
Animal Einsteins:
Discovery

Clip 8
SOURCE:
Animal Einsteins:
Discovery

(View Video Clip 7)
(View Video Clip 8)
CDEF: Communication

C: sound uttered in response to stimulus is rewarded with verbal bridging & something to chew
D: these sounds vary among individuals, depending on what is in their environment; propensity to learn is heritable
E: convergent- African Grey parrot and humans both mimic voices
F: those genotypes that mimicked social companions were more likely to get food and keep mates

CDEF: Awareness

C: when ape looks in the mirror, he touches a dot painted on his own forehead (does not touch the mirror)
D: depends on previous experiences with mirrors
E: divergence- monkeys do not pass the mirror test, chimps, orangs, gorillas, humans do
F: those that were aware of their own body were better able to control effects of their actions on others

Key author: Cecilia Heyes

What would be the genetic basis for intelligence?
Q2.1 People use many "yardsticks" to measure intelligence; here are a few; let's start with an example of learning that you may relate to...

- Learning (e.g., clicker training)
- Problem-solving (e.g., ravens pulling string)
- Communication (e.g., Alex learns words)
- Awareness (e.g., chimp mirror test)

Let's practice CDEF with another type of intelligence.
Learning Goals

How- social transmission occurs
Why- social transmission evolved

Let's review where we are on our concept map.

Three take-home messages from Halliday (1994:134) re. Keyword concepts related to Adapting

- Flexible: Learned intelligence
- Flexible/Fixed: Culture (short hand for Social Transmission)
- Fixed: Inherited Instinct (equivalent to “evolutionary change”)

What is social transmission, i.e. culture?

- Shared values, beliefs and norms of behavior passed between generations
- Social transmission of information
  - within generations
  - between generations
- Adapting behavior - not genetic
  - shorter time-frame than evolution
  - longer time-frame than individual lives
  - not every individual has to learn by trial & error

- Culture (social transmission) - somewhere between fixed & flexible
  - Mental model: fixed pre-adapted propensity to learn from social companions
  - Young animals are likely to watch social companions and learn what to expect, followed by individual trial & error learning

Some anthropologists point out the differences between humans and other animals, stating that only humans have culture. Yet some animals show social learning, which is hypothesized to be a precursor to culture.
Communication occurs in the context of foraging for food together. Consider this example of the chimpanzees in Gombe, reported by students of Richard Wrangham. This illustrates social transmission because younger chimps learn from older chimps.

You can learn more about the interaction of genes and environment in shaping the vocalizations of chimpanzees by searching for the key word “pant hoot” and “Wrangham RW”.

(View Video Clip 10)

CDEF - Social transmission by “pant hoots”

Q2.3

- C: chimps pant hoot in response to exciting source of food; hoots vary between groups
- D: within constraints, individuals learn variations of timing and pitch
- E: inertia- both humans and chimps have a propensity to learn certain sounds; divergence- more variation in humans than chimps
- F: those genotypes that recruited allies were better at defending food clumps, so they ate better, survived better, and made more copies of the genotype

Lets apply the four perspectives of ethology to this trait

The similarities between chimps and humans are hypothesized to be due to phylogenetic inertia (shared genes)

The differences are hypothesized to be due to divergence of genotypes during evolutionary history. Given what you learned in the last presentation, what might you hypothesize that the divergent genotypes code for in terms of brain anatomy?

The ability to use tools has been cited by anthropologists as a trait that distinguishes humans from other animals.

Learn more about this study by C. Boesch, using the keywords “tools” AND “chimpanzee”

(View Video Clip 11)
Development- Social Learning of tool-use

- C: infant watches mother use tool and tries to crack nuts
- D: juveniles are more likely to observe mothers; less likely as their behavior changes with age (weaning then puberty)
- F: those genotypes that learned by observation were more likely to have gotten more food in hard times; compared to those that only learned by individual trial and error
- E: H1- ancestral precursor to imitation in humans?

Example: social hunting

Social transmission occurs during group hunting of colobus monkeys when chimps learn what to expect from each other.

You can learn more about this study from the book by Craig Stanford. (View Video Clip 11)

Development of social hunting

- C: chimps learn to expect how prey respond to companions
- D: learned- young chimps watch as adults hunt; ability to learn socially may be heritable
- F: those genotypes that learned from companions were more likely to get protein
- E: H1- ancestral precursor to social learning in humans?

Let's practice applying the four perspectives of ethology to this trait.

How is group hunting similar and different from culture in humans?
Summary: Culture is social transmission

- **Social context of learning**
  - PD: “sets the stage” for learning by juveniles
  - PC: followed by individual trial & error learning

- **adaptation to changing environment** (intermediate time scale)
  - faster than evolutionary change in the gene pool of each species
  - depends on relations between generations
  - Slower than individual trial & error because it depends on learned transmission between generations

Humans differ more in degree, than in kind

Action Items

- Prepare answers for
  - Q2.3 What is social transmission…
  - Q2.4 How does it develop…..

- Search Web of Science
  - Keywords: “social learning” in “Animal Behavior” or
  - Key authors: “Wrangham RW” “Heyes, C”

- Search Google Scholar
  - Key authors: “Craig Stanford” “C Boesch” “Uehlenbrock, C”

- Dialogue
  - Volunteer to chat on Q2.3, Q2.4
  - Post examples/sources to Blog Unit 2

Using what you learned from searches, post answers for these two Discussion questions, in preparation for the Final Exam.

Q2.3 How does adaptation by social transmission occur? (TIP: PC define stimulus/response and give example)

Q2.4 Why does social transmission function on an intermediate time scale (TIP: UF compare to learning and instinct)?
Learning Goals
Instinct- cause & function
Explain the logic of natural selection (relate CDEF to VHDP)

Lets review how instinct relates to the concepts of culture and learning.

• Instinctive behavior is Fixed,
  • Mental model: the genotype determines neuronal connections
  • all individuals are the same and the behavior is like a reflex, not modified by learning, only by maturation of nerves & hormonal systems
  • Instincts are a result of natural selection operating on a geological time scale in shaping the proportion of genotypes in a species
  • In Folk Psychology terms, instinct solves problems encountered consistently over the evolutionary history of the species

Lets elaborate a bit more on the meaning of this concept. Why do we say instinct is more on the “fixed” end of the behavioral continuum?

Is instinct more like hardware or software? Why?
Here is an example of an instinctive response. Archer fish spit at moving objects like crickets, and eat them when they fall in the water. The behavior is highly heritable, appears fully formed the first time, and changes little over a lifetime, although individuals learn where and when to expect food.

Where would you place this behavior on the continuum of fixed instinct to flexible learning? Why?

(View Video Clip 12)

In Folk Psychology terms, fixed instinct is more like “intuition” than “intellect”.

How well does this logic apply to the “spit” behavior of the archer fish?

The four perspectives of ethology are related to each other due to the logic of natural selection. This is why Tinbergen chose these questions for the basis of the concept map.

Lets practice applying this logic to the archer fish example. I would suggest using the memory handle “VHDP” to remember the 4 logical steps of natural selection. Recall that the “How” questions are proximate (PC & PD) and the “why” questions are ultimate (UE & UF)

In your own words, explain how the four questions (CDEF) relates to the logic of natural selection (VHDP)
Let's apply this to another example of instinctive behavior that was studied by Tinbergen, the long call display signal of herring gulls and black headed gulls.

To learn more about this example, search for “long call gulls”

(View Video Clip 13)

Practice applying the logic of natural selection to one of the instinctive behavioral displays of gulls; the long call.

How would you apply this logic to another of the instinctive behaviors in the previous video?

Where would these behaviors fit in the continuum of fixed instinct to flexible learning?

Let's apply this to another example of instinctive behavior that was studied by Tinbergen, the long call display signal of herring gulls and black headed gulls.

To learn more about this example, search for “long call gulls”
Artificial selection: herding behavior

- V – Variation (PC)
  - If collies varied in herding skills (very good 33%, good 33%, poor 33%)
- H – Heritability (PD)
  - If herding skill was 60% heritable
- D - Differential Fitness (UF)
  - If "poor herders" were not bred by farmers and "very good herders" were bred to "very good herders"
- P - Proportion of genotypes changes (UE)
  - Then in the past, a lineage of collies with 66% "very good herders" would have diverged as better than average for the gene pool of the breed

Practice applying the logic of natural selection to one of the instinctive behavioral displays of gulls; the long call.

How would you apply this logic to another of the instinctive behaviors in the previous video?

Where would these behaviors fit in the continuum of fixed instinct to flexible learning?

Critical thinking: myth or science?

- Assumptions- do all these fit?
  - there was variation in the trait (V)
  - the variation was not learned (H)
  - only this one trait influenced differential reproduction (D)
  - no other trait had an opposite advantage (P)

- Can we assume the current environment is the same as during the past history of this species?

To distinguish between a Folk Psychology explanation for adaptive behavior, and a Scientific explanation, ask yourself these questions.

If one of these assumptions was not met, explain why you would expect natural selection NOT to have shaped the instinctive trait due to changes in genotypes. Practice thinking through the logic by playing this “thought game” for each of the assumptions.

Use what you have learned to answer the question Q2.6 “How does the basic questions in ethology (CDEF) relate to the logic of natural selection (VHDP)?”

Artificial vs. Natural Selection

- Similarities
  - Variation is heritable
  - Change in proportion of genotypes is related to differential fitness (survival & reproduction)
  - Both are constrained by genetics (can’t breed for purple dogs)

- Differences
  - Humans determine which genotypes survive & reproduce
  - Artificial selection is more consistent in line breeding
  - Artificial selection happens over fewer generations

Apply what you have learned about the concept of natural selection, to the logic of artificial selection, practiced by breeders in producing domestic animals.

Think about what is similar and what is different.
Summary

Q2.5, Q2.6

- Heritable instinct
  - relatively "fixed" compared to adaptation by flexible learning
  - an adaptation to "problems" on a long-term time-scale

- The logic of natural selection (VHDP) is the foundation of Tinbergen’s four Basic Q’s in ethology (CDEF)
  - Variation (Cause)
  - Heritability (Development)
  - Differential fitness of genotypes (Function)
  - Proportion of genotypes changed in the gene pool (Evolution)

- The logic of artificial selection and natural selection is similar, but they differ because
  - Humans choose which genotypes live & breed more than others
  - Line-breeding is more consistent than natural selection
  - Change in the gene pool is more rapid than natural selection

Learning Goals

- Instinct- cause & function
- Explain the logic of natural selection (relate CDEF to VHDP)

Using what you learned from searches, post answers for these two Discussion questions, in preparation for the Final Exam.

Q2.3 How does adaptation by social transmission occur? (TIP: PC define stimulus/response and give example)

Q2.4 Why does social transmission function on an intermediate time scale (TIP: UF compare to learning and instinct)?