**The Study of Behavior**

*Historical Background*

**Shakespeare on Instincts**

"I'll never be such a gosling to obey instinct, but stand as if a man were author of himself and knew no other kin."

--- Coriolanus, ca. 1608

**Humans vs. Animals**

*Descartes in 1600’s:*

animal’s behavior governed solely by the laws of physics,

whereas human beings had a soul, which was thought to reside in the pineal gland...

Humans, unlike animals, had free will.

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**Cartesians created a dichotomy**:  

humans as reasoning beings  

vs.  

animals as automata

*dichotomy* = two-part classification

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**The learning-instinct dichotomy**

Eventually known that animals could learn, and behavior still pitched as:

learning  

vs.  

instinct
Lamarck on Instincts

“By instinct is meant the fixed tendencies displayed by animals in their actions; and many people have held that these tendencies are the produce of a reasoned choice, and therefore the fruit of experience.”

Evolution by Use and Disuse

“...the continued use of any organ leads to its development, strengthens it, and even enlarges it, while permanent disuse of any organ is injurious to its development, causes it to deteriorate and ultimately disappear if the disuse continues for a long period through successive generations.”

J.-B. de Lamarck
Philosophie Zoologique (1809)

Will body-building cause one’s children to be more muscular from birth?

NO!

Problem with Lamarck’s Theory

- Required effects of environment on non-reproductive tissue be transmitted to DNA in gametes
- ‘Refuted’ by August Weismann in early 1900’s
Charles Darwin, 1809-1882

- Dropped out of medical school
- Studied theology at Cambridge
- Held lifelong interest in nature

1831-1836
Naturalist aboard the H.M.S. Beagle

Darwin’s principle of antithesis

Darwin observed that instincts could often be grouped as pairs of opposites.

- Aggressive posture
- Submissive posture

Charles Darwin’s *Origin of Species*

* Published in November 24, 1859

* Evolution* through a process of natural selection

* term ‘evolution’ never appeared in “The Origin of Species”!
Hypothetical Example
Natural selection on beetle color pattern

1. Individual beetles vary in color pattern.

2. Variation in color pattern is partly genetically-based.

3. Some color pattern genotypes reproduce more than others. Perhaps predators favor black beetles.

4. Predation is the agent of selection on color pattern. Color pattern has evolved under natural selection.
Natural selection results in a change in **allele frequencies** in a **population** at one or more loci.

Please review knowledge of basic genetics at introductory biology level.

Some beetles can change their color in a minute or so!

This is NOT evolution.

This is called **phenotypic plasticity**.

Charles Darwin proposed that natural selection acted on behavior like any other trait.

**Darwin's theory of pangenesis**

acquired traits sometimes transmitted via **gemmules** (= cells shed by somatic cells).

behavior learned in one generation could be expressed instinctively in the next.
George Romanes (1880's), disciple of Darwin

Primary instincts arose through natural selection.
Secondary instincts were derived from learned behavior, through 'lapsing intelligence.'

Romanes established 'mental continuum'.

Emotion
- Shame, deceit
- Revenge, anger
- Grief, hate, cruelty
- Pride, resentment
- Sympathy
- Affection
- Jealousy, anger
- Pugnacity, industry, curiosity
- Sexual feelings
- Surprise, fear

Animals in which emotion first appears
- Apes, dogs
- Monkeys, elephants
- Carnivores, rodents
- Birds
- Ants, bees, wasps
- Crustaceans
- Fish
- Insects, spiders
- Molluscs
- Larvae of insects, segmented worms

Return to Nature-Nurture:
Instinct and Learning

Exciting times! Evidence of Lamarckian effects of environment on phenotype is growing.
Some epigenetic effects involve methylation of DNA.
Definition of the term **instinct** is difficult.

“I will not attempt any definition of instinct. …but everyone understands what is meant, when it is said that instinct impels the cuckoo to migrate and to lay her eggs in other birds’ nests.”

C. Darwin
*On the Origin of Species*

Cuckoo is a brood parasite; it lays eggs in nest of host species.

Characteristics of Instincts

- fixed
- stereotyped
- triggered by releasers

Instincts are **fixed**.

Chameleon’s prey strike behavior is always the same.

Instincts are sometimes referred to as **fixed action patterns**.

Instincts are **stereotyped**.

Sequence of stereotyped fixed action patterns in mallard drake courtship behavior:

- “Bill-shake”
- “Great-shakes”
- “Tall-shake”

Instinctive behavior is **species-typical**, varying greatly **between** species but little **within** a species.
Instincts are triggered by **releasers**.

Releasers are stimuli that elicit behavior. Releasers represent a small subset of available stimuli.

**Example**
In stickleback fish, a **red belly** acts to release territorial behavior by males.

Releasers of Human Instincts

**what makes babies smile**

| yes! | yes! | Of course! | yes! | NO |

Conclusion: A **pair of eyes** releases a babies smile.

Instincts frequently **run to completion** even in the absence of releaser.

**Example**
Egg-rolling in greylag **geese** (work by Konrad Lorenz)

Egg-rolling sequence

Goose continues to 'roll' egg into nest even though egg has been taken away by Lorenz.
Learning

- Learns alarm calls
- Remembers where it stored seeds
- Learns to use tools
- Learns colors of flowers

Characteristics of Learning

- Repeatable change in behavior with experience
- Change is gradual
- Change wanes without more experience
- Change usually benefits the animal

Landmark learning in digger wasps

Digger wasp females bring food repeatedly to burrow where young are developing.

Niko Tinbergen showed that females learned to use local landmarks to find nest entrance.

Conditional discrimination learning

Animal learns to respond to A when B is presented, but to C when D is presented.

Response to A versus C is conditional on B versus D.

Example: Cuttlefish maze experiment (video)
Two Problems with the Learning-Instinct Dichotomy

1. Instincts may be partly learned.
2. Learning is often innately biased.

Example. Food begging behavior in herring gulls

Chicks beg for food by pecking at mother's bill.
Mother then regurgitates a meal.
Tinbergen analyzed releasers for begging behavior by chicks.

Tinbergen made models of mother bird and waved them in front of chicks.

A yellow bill with a red spot was sufficient to release food begging behavior.

Jack Hailman extended Tinbergen's experiments with laughing gulls.

Releasers of food begging changed as chicks matured.

At first, maximal response to model of orange bill. But later, maximal response required more complete model.
Conclusion:
What was thought to be an 'instinct' was at least partly learned!

WHY is feeding behavior organized in this way?

Problem #2: Learning can be biased.

Example: Avoidance learning in rodents

Rats learn to avoid taste associated with an illness.
This is called food aversion learning.

Rats also learn to avoid sounds associated with electric shock.

But rat cannot learn sound/nausea and taste/shock.

Why have such biases?
Butterfly Egg-Laying Behavior Is Mixture of Learning & Instinct

Female pipevine swallowtail butterflies (*Battus philenor*) lay eggs on 'host plants' in the genus *Aristolochia*.

How does *B. philenor* find and identify its host plants?

Once on host plant, egg-laying elicited by phytochemical releasers. This part is instinctive...

But finding host plant is both instinctive and learned.

We made artificial host plants as follows:

\[ \text{paper model} + \text{host extract} = \text{training model} \]
We then trained a female to one of four colored models:

Females then search in array of untreated targets:

Landings tallied by color.

Butterflies perform well on all colors. Best on green.

Are they prepared to learn green or do they just respond innately to green?
Pattern of mistakes suggests that females respond instinctively to green.

Why have innate green bias but be able to learn other colors?

Green is most common color of host across the butterfly's range. But in southern Arizona, host species comes in different colors. But it pays to learn red.

What about color preference when foraging for nectar?

Study by Lisa Wang

Hues: Blue, Green, Yellow, Orange, Red

Brightness: 100%, 50%, 10%, 1%
LED "flowers" allow for finer control in manipulating hue and brightness.

B. philenor shows an innate preference for blue hue when visiting flowers.

Butterflies can learn to forage for various colors;

Once again, we see a mixture of instinct and learning.