

Evolution and Learning

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Is genetic evolution relevant?

- ▶ Humans learn.
- ▶ Behavior not rigidly programmed by genes.
- ▶ So what is the point of this course?

Outline

- ▶ What is learning?
- ▶ Ease of learning
- ▶ Facultative adaptations
- ▶ Evolution of facultative adaptations

What is learning?

- ▶ Learned behaviors respond to the environment.
- ▶ Some behaviors are learned only during a critical period.
- ▶ Others can be learned throughout life.

Ease of learning

- ▶ Vocabulary: 60,000 words by age 17
- ▶ Average learning rate: 10 words per day btw ages 1 and 17.
- ▶ All without effort.
- ▶ Yet we struggle with the multiplication table.

Ease of learning

Toilet training takes

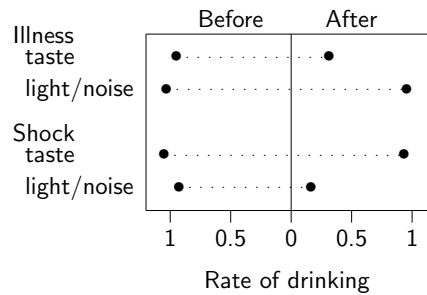
- ▶ several years for human children.
- ▶ about 30 seconds for a kitten.
- ▶ Yet humans learn other things faster than cats.

We learn some things more easily than others, and these differences make ecological sense.

Experiment of Garcia & Koelling (1966)

- ▶ Make rats thirsty.
- ▶ Give them water along with a signal:
 - ▶ tasty water
 - ▶ bright noisy water
- ▶ Then something unpleasant; either:
 - ▶ induce nausea
 - ▶ electric shock
- ▶ Offer water again, along with signal.
- ▶ How many of them drink?

Results of Garcia & Koelling



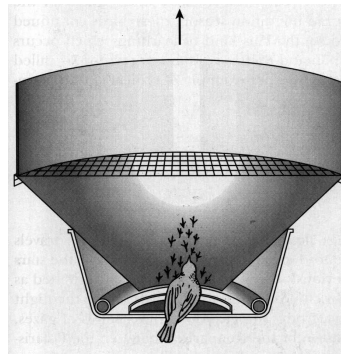
- ▶ Illness teaches rats to avoid tasty water but not bright-noisy water.
- ▶ Shock teaches rats to avoid bright-noisy water but not tasty water.

Implications of study

- ▶ It makes sense to associate
 - ▶ nausea with what you drank
 - ▶ physical pain with lights and noise.
- ▶ The rats were able to learn associations that make ecological sense.
- ▶ Unable to learn those that make no sense.

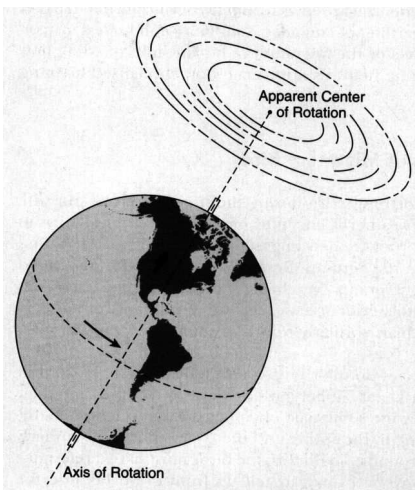
Learning is adaptive in rats.

How do birds navigate?



- ▶ Put bird inside paper cone
- ▶ Ink pad under feet.
- ▶ Footprints record hops.
- ▶ In Fall, birds hop South.
- ▶ How do they know which way is South?

Axis of rotation points true North



- ▶ On cloudy nights, birds hop at random.
- ▶ On clear nights, they hop South.
- ▶ Unless raised indoors,
- ▶ in which case they hop at random.

Emlen experiment with Indigo buntings

- ▶ Birds raised indoors
- ▶ Projected night sky on ceiling
- ▶ Stars revolved around Betelgeuse (not Polaris)
- ▶ Hopped away from Betelgeuse (not South)
- ▶ Birds learn N from rotation of stars
- ▶ A specialized adaptation of enormous value to birds.

Human incest avoidance

- ▶ People everywhere avoid mating with close relatives.
- ▶ Most don't even *desire* such matings.
- ▶ Makes sense: inbreeding leads to congenital defects.
- ▶ But how are these desires inhibited?

To find out, we turn to Israeli kibbutzim.

Marriage on Israeli Kibbutzim

- ▶ Children raised in communal nurseries.
- ▶ Of 2769 marriages, *none* were within groups that had lived together since birth.
- ▶ Such marriages are allowed, but young people are not interested.
- ▶ Seems to be the mechanism that prevents people from lusting after siblings.

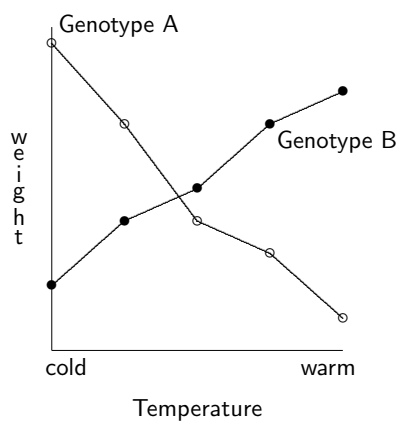
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Facultative adaptations

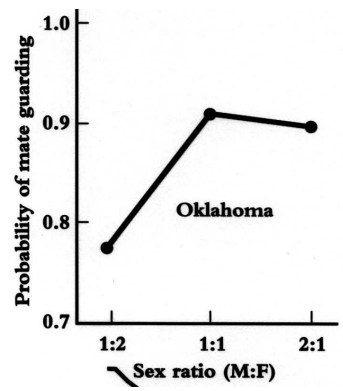
- ▶ A character that responds to the environment is said to be *phenotypically plastic*.
- ▶ When plasticity is adaptive, it is a *facultative adaptation*
- ▶ Learning is a facultative adaptation.
- ▶ Skin tanning is another
- ▶ Response to cold, heat, altitude, & disease
- ▶ How do such adaptations evolve?

Norms of reaction



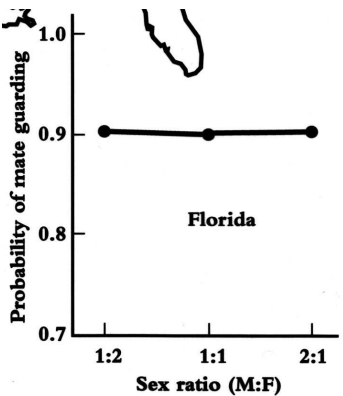
- ▶ B grows larger in warm climates.
- ▶ A grows larger in cold climates.
- ▶ Selection for either would produce plasticity.

Oklahoma Soapberry bugs



Males guard more when they have lots of competition

Florida Soapberry bugs



Males guard no matter what.

Why do OK and FL differ?

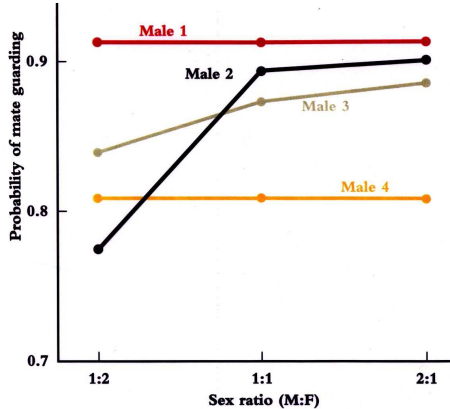
Florida

- ▶ warm
- ▶ soapberry bug populations stable
- ▶ sex ratio doesn't vary
- ▶ facultative adaptation not needed

Oklahoma

- ▶ harsh winter
- ▶ soapberry bug populations fluctuate
- ▶ sex ratio varies
- ▶ facultative adaptation needed

Individual variation



- ▶ Different males respond differently
- ▶ Different norms of reaction
- ▶ These differences are heritable
- ▶ If they affect fitness, they will evolve.

Summary

- ▶ Some things are easy to learn, and some are hard.
- ▶ What is hard for one species is easy for another.
- ▶ These differences make ecological sense.
 - ▶ Human children learn words, and who not to mate with.
 - ▶ Rats learn some associations but not others.
 - ▶ Birds learn to navigate.
- ▶ Learning is a kind of facultative adaptation.
- ▶ It evolves like any other facultative adaptation.

Evolution of facultative adaptations

Requires

- ▶ Variation in norms of reaction.
- ▶ Different norms of reaction must have different fitness.
- ▶ Norms of reaction must be heritable

These conditions have been shown to exist among Soapberry bugs.