Chapter 3
The Development of Behavior: A Focus on Heredity
(2nd Lecture)
One way to study the genetics of behavior is to use Mendelian genetics.

Larval fruit flies, *Drosophila melanogaster*, have a tendency to move around as they eat. However, the strength of this tendency varies among larvae. Some are classified as “sitters” and others as “rovers.”

One way to determine whether the behavioral difference between the groups is mediated by a single gene is to conduct a classic Mendelian crossing experiment.

What can you conclude about the behavioral differences?
One can also test for the genetic basis of behavior in a more precise manner:

Use molecular biology techniques to knock-out specific genes, and assess the behavioral consequences

One can create two strains of mice that are identical in every respect, except for a single gene that encodes an enzyme called α-calcium-calmodulin kinase

The absence of this one enzyme causes the hippocampus (a region of the mammalian brain thought to be involved in spatial learning) to develop abnormally
Results of a test for spatial learning in wild-type (i.e., control) and mutant (i.e., $\alpha$-calcium-calmodulin kinase knockout) mice

Morris water maze test for spatial memory

Path of a swimming mouse as it searched for the hidden platform (started at green and ended at red circle).

Note the presence of visual “landmarks” that the swimming mouse can use to remember the location of the platform, and thereby facilitate “escape” from the water.

Following training, the mice were subjected to one of two conditions:

the platform was put in the same position as during training (training trials) or in a new random position (random trials)

What can we conclude from this study?
Another knockout mouse is missing the *Oxt* gene, which makes it impossible for the brain to produce oxytocin.

Behavioral studies have revealed that male knockout mice have a type of social amnesia, which prevents them from remembering females with whom they have interacted recently.

![Typical investigation of a female by a male mouse](image1)

![The duration of the investigation typically declines with repeated trials in wildtype (+/+) mice, but remains high in knockout (-/-) mice](image2)

This memory deficit does not generalize to food odors.
So far, we have been discussing ways to demonstrate that genetic differences can lead to behavioral differences among individuals.

Furthermore, we have seen that differences in the allele for a single gene can have large behavioral effects.

Why are these observations of evolutionary importance?

Because they indicate that certain alleles could have spread or disappeared in the past depending on how they impacted reproductive success.

Next, we will examine this proposition.
If behavior responds to natural selection, then we should be able to increase or decrease the prevalence of a particular behavior through artificial selection.

Test of prediction: response of female mice to artificial selection on nest building behavior.

What can we conclude from this study?
What selective forces in nature could have produced a similar change in behavior?
If behavior responds to natural selection, then we should be able to increase or decrease the prevalence of a particular behavior through artificial selection.

*Test of prediction:* response of crickets to artificial selection on calling duration.

In this case, an investigator “selected” against males that exhibited calls of intermediate duration.

What selective forces in nature could have produced a similar change in behavior?
In some cases, selection can favor the maintenance of genetic and behavioral variation within a species.

For example, why do you suppose there are both rover and sitter larvae in populations of *D. melanogaster*?

Another example of this phenomenon concerns garter snakes in the western US.

One population inhabiting coastal California specializes on a superabundant, but largely non-utilized food resource (banana slugs), whereas a more inland population does not because the slugs are not present.

Did the coastal population evolve a specific preference for the slugs?
Hypothesis
The coastal snake populations have evolved a preference for the banana slugs

Prediction
Newborn, naïve garter snakes from coastal populations should prefer the slugs, while those from inland populations should either avoid or act indifferently towards the slugs

Here, newborn snakes from both populations were offered 1 chunk of banana slug/day for 10 days

Score (on x-axis) = total number of chunks eaten over 10 days of experiment

What can we conclude from this experiment?
Hypothesis
The preference for banana slugs in the coastal population is mediated in part by odor

Prediction
Newborn, naïve garter snakes from coastal populations should investigate cotton swabs dipped in slug extract more intensively than snakes from inland populations

Here, newborn snakes from both populations were offered a cotton swab dipped in slug extract

The number of tongue flicks directed at the swab over a 1-min trial was recorded

What can we conclude from this experiment?
How could we test for the possibility that these results reflect the fact that the snakes from the coast investigate all novel odors more intensively?
What can we conclude about the evolution of the slug preference?

It appears that the geographic differences in the feeding responses to slugs is due in part to heredity:

Different alleles appear to predominate in the two populations that influence the appetitive response to slugs and their odors

Thus, selection must have favored the increased prevalence of specific genes and chemosensory mechanisms in the coastal population that promoted the ability to exploit a superabundant and non-utilized food resource.