HEREDITY
- nature (genotype)

ENVIRONMENT
- nurture

BEHAVIORAL TRAIT
- phenotype

quantitative genetics → presence & nature of genetic influences

molecular genetics → identifying & locating specific genes in the genome
Animal Studies

Simple genetic breeding studies used to demonstrate presence of genetic influence on behavior:

1. selection studies

2. inbred line studies

DOGS

Canis familiaris sub-species = breeds

- original animals subjected to thousands of years of selective breeding by humans to produce present-day breeds (breed = inbred line)

- breeds differ for many traits:
  - physical appearance size intelligence temperament emotionality activity level aggressiveness
  - all of these traits must show some genetic influence for them since they breed-true, even after cross-fostering and varying environments
  - genetic component of variance
Research by Scott & Fuller (1965)

• 20 years of study into dog behavior

5 breeds of dog:
  fox terrier
  cocker spaniel
  basenji
  beagle
  Shetland sheepdog

variance between breeds much greater than variance within breeds

Methods of study use the following:

• variance within breeds (= within inbred strains variance)
• comparisons between breeds (= between inbred strains variance)
• crosses between breeds (to form $F_1$ hybrids)
• cross-fostering to test for maternal effects on behavior (environmental effect)
• behavioral traits: emotionality, trainability, problem-solving, sexual behavior, sociability

For each measured trait:
variance within breeds =

variance between breeds =

variance between – variance within =
**Selection studies**
- successful selection for a trait provides evidence the trait is heritable
  - under the influence of genes
    - high line
    - low line
    - control line

Examples
- response to alcohol: ethanol sleep time
- learning: maze-learning ability
- anxiety levels: open field behavior

**Open field behavior in mice**
- mouse placed in brightly-lit box for 6-minute trials

Fearful mouse

Non-fearful mouse
**Selection for activity level**
high line: mate together highest scoring mice for activity in the open field each generation
low line: mate together lowest scoring mice

**Selection for defecation level**
- high line: mate together highest defecators
- low line: mate together lowest defecators

**Results**
after 30 generations of selection:
for activity:

for defecation:

no overlap in scores between high and low line

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**What else can a successful selection study tell us?**
- by analyzing response to selection over the generations:
  1. can get an estimate of number of genes influencing the trait
  2. can get idea about nature of gene action

Examples:
large initial difference between lines in a few generations then leveling off of response indicates fewer genes, non-additive gene effects

smaller differences between lines continuing for many generations indicates more genes, additive gene effects
INBRED STRAINS

Different inbred strains may have different alleles fixed at the loci influencing a behavioral trait.

Differences in phenotype between strains will reflect these genetic differences between strains if the trait is influenced by genes.

Note: alleles (and hence, phenotypes) are fixed at random, there is NO selection involved in producing inbred strains.
What can studies of inbred strains tell us?

1. strain differences in phenotype prove genetic influence on the phenotype

2. genetic and environmental variance can be estimated

3. crosses between inbred strains will tell us the nature of gene action

Examples
Diallel design maximizes information from inbred strain studies
- systematic cross-mating of several inbred strains, with reciprocals
- reciprocal cross differences indicate sex-linkage, prenatal maternal influences
Cross-fostering can separate pre- and post-natal maternal effects
Environment can be manipulated to study environmental effects

Use of rat and mouse consomic strains to identify genes

- consomic strain =

- by introducing genetic material in a systematic way, genes that influence a behavior can be discovered
Example
Strain A shows high deficit for long-term fear memory
Strain B shows low deficit for long term fear memory
- introduce 1 chromosome from Strain B at a time into Strain A animals, making a series of consomic strains
- see which chromosome rescues the deficit
- narrow down the search by introducing smaller & smaller pieces of chromosome