Psych 3102
Introduction to Behavior Genetics
Lecture 9
Methodology in Behavior Genetics
Animal studies

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

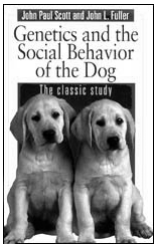
beagle

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

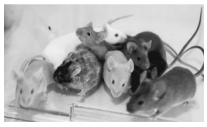


For each measured trait:

variance within breeds =

variance between breeds =

variance between – variance within =



MICE and RATS

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

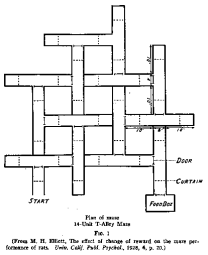


Fig. 1
(From M. H. Elliott, The effect of change of reward on the maze performance of rats. Univ. Calif. Publ. Psychol., 1928, 4, p. 21.)

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 :

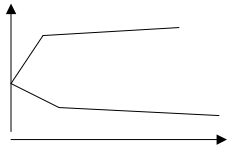
no overlap in scores between high and low line

What else can a successful selection study tell us?

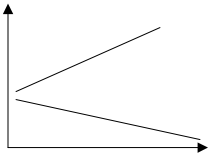
- by analyzing response to selection over the generations:
  1. can get an estimate of number of genes influencing the trait
  2. can get idea about nature of gene action

Examples:

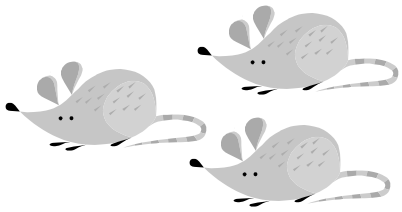
large initial difference between lines in a few generations then leveling off of response indicates fewer genes, non-additive gene effects



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



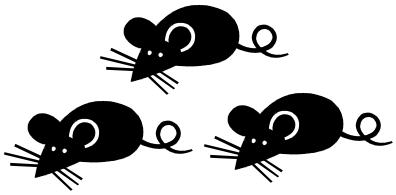
Strain A



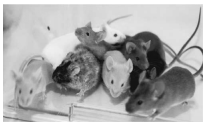
Strain B

INBRED STRAINS

Strain C



Inbred strain studies



inbred strain (line)

-

-

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

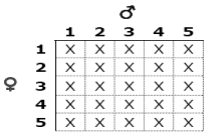
3. crosses between inbred strains will tell us the nature of gene action

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