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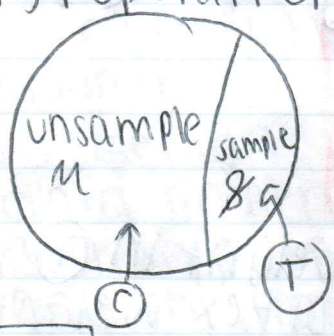
## Lecture #6: Experimental Design

- Outcome ($Y$): cortex weight in mg
- Treatment ($X$): < (T) enriched = ~~treatment~~
  (C) deprived = ~~control~~
- subjects: rats (male)
- Goal (R. A. Fisher ≈ 1920): try to make (T), (C) groups as similar as possible in all relevant ways except for (T)/(C) distinction

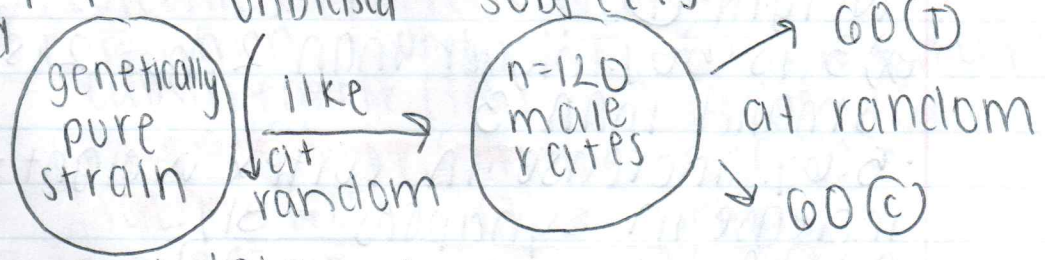
(P) population (Neyman ≈ 1920)

- simplest solution: assign rats to (T), (C) at random




- R-36 ⇒ flowchart for classifying experimental design (for HW 2 and midterm)
- Design 1 - get 120 male rats from genetically pure strain, assign 60 at random to (T) and other 60 to (C).

completely randomized design (CRD) ↳ valid




- Design 1 data set:

cortex weight + (T)

$$\begin{bmatrix} 689 \\ 702 \\ | \end{bmatrix}$$ (mg)

$n_1 = 60$

mean $\bar{Y}_1 = 683$ mg

SD $S_1 = 32$ mg

cortex weight + (C)

$$\begin{bmatrix} 655 \\ 693 \\ | \end{bmatrix}$$ (mg)

$n_2 = 60$

mean $\bar{Y}_2 = 647$ mg

SD $S_2 = 30$ mg

Q,) Is 683 mg different from 647 mg by an amount that's large in practical (biological) terms?

practically (pract sig) ~~significant~~

A,) First, 683 is $683 - 647 = 36$ mg heavier. $(\bar{y}_1 - \bar{y}_2)$ = absolute comparison

Second, $\frac{683\text{ mg} - 647\text{ mg}}{647\text{ mg}} = \frac{+36}{647} = 5.6\%$

relative comparison

$$\frac{\bar{y}_1 - \bar{y}_2}{\bar{y}_2}$$

- The mean cortex weight in (T) was 5.6% larger than mean cortex weight in (C).

$\frac{647\text{ mg} - 683\text{ mg}}{683\text{ mg}} = \frac{-36}{683} = -5.3\%$

(relative to #1 in treatment group)

The mean cortex weight in (C) was 5.3% smaller than mean cortex weight (T).

ex) 3 is 50% bigger than 2, but 2 is only 33% smaller than 3

- 5.6% increase in cortex weight → $(5.6\%)^2$ increase in synapses = 31%

A,) Yes! (bc of synapses)

- 0.1% relative diff. → small in practical terms

5.6%

43% ← large in practical terms

- Heuristic (approximate) rule: relative differences of 5% or more, are often large in practical terms, smaller relative differences than 5% can also be pract sig, especially if they accumulate over time
  Ex) a change of 1% per year, sounds small, but over a 10-year period it's very big

Q) In design 1 is it fair to conclude that the diff (5.0%) was caused by (T) vs. (C) environment?

Q) Is design 1 unbiased?

- A data gathering method is unbiased if, when repeated hypothetically and the results averaged you get the right answer
- Bias: a systematic tendency to get the wrong answer, either high or low side
- A design is valid for causal conclusions if it's unbiased
- Completely randomized design = randomized controlled trial (RCT) - used in medicine

(I) (outcome) (correct weight)

X (treatment: supposedly causal factor (SCF)) ← (T) enriched environment, (C) deprived

Z (potential confounding factor (PCF)) (The enemy) ← confusing

- Z is a PCF is 2 similar variables ☑ and ☑ are associated if, when 1 ↑ other tends to ↑ or ↓ on average

↑ positive association

↓ negative association

• Z is PCF if:
- its plausible that Z, Y are associated
- its plausible that Z + X are associated

• How to defeat bias from PCFs - 2 ways:

① At ~~design time~~

valid (A) simple, but less accurate - randomize to T C

valid (B) more complicated, but more accurate - matched pairs

② At ~~analysis time~~

• Strong way to defeat a PCF: hold it constant.

Design ② litter T C

-2 brothers, pair from same litter

| | 683 | 067 |
|---|---|---|
| 2 | | |

special case of rand. blocks (block size = 2)

matched pairs

-choose 60 litters like at random, then 2 brothers from each litter

1 T

1 C

at random

block

| enriched | normal | deprived |
|---|---|---|
| | | |

randomized blocks design

• Insomnia (L-88)

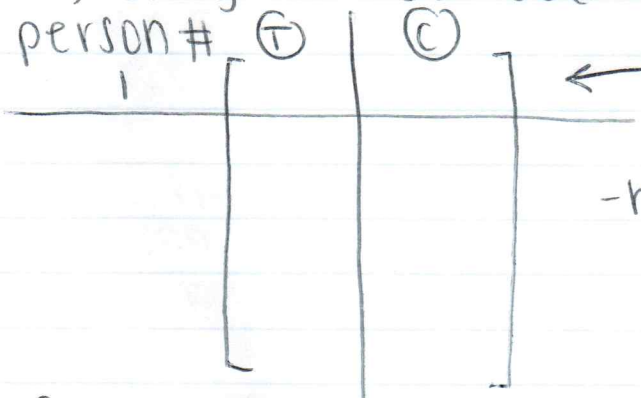
Y (outcome): # hrs. sleep

X (treatment) < T drug - blue pill active ingredient

C ~~no drug~~ - blue pill inactive ingredient

Ⓣ blue pill
Ⓒ nothing ← all subjects know which group they're in

- Placebo effect: people sometimes respond to the idea of treatment rather than treatment itself
- Placebo: inert substance, looks just like treatment intervention
- subjects don't know if in Ⓣ or Ⓒ - blinding subjects to Ⓣ/Ⓒ status (good precaution)
- Also possible and good to blind experimenters to Ⓣ/Ⓒ status: double-blind if both
ex) drugs to combact insomnia




← same person in any given row

-holds ALL PCFs constant

- Repeated Measures Design (longitudinal design)
→ time
follow same person along in time

- Cross-sectional - opposite longitudinal, diff subjects at 1 point in time