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## Chapter 2: Experimental Design

### 2.1: Randomized Controlled Experiments

Does psychological environment affect the anatomy of the brain?

y = outcome (dependent) variable (brain anatomy)

x = treatment (independent) variable (psychological environment)

← enriched (1) vs. deprived (0)

- Experiment: Enriched rats (treatment group)

- 12 to cage, given toys

Deprived rats (control group)

- alone, no toys

- Design 0

• 120 rats, raised until adult maturity

• all are put in an enriched environment

Factual Data: what actually happens

- mean cortex weight = 683

Counterfactual Data: point of comparison

- mean cortex weight of same rats if they had received the deprived environment

What's wrong with this design?

- there is no counterfactual data, nothing to compare the enriched rats to.

Solution: Design 1

- Design 1

• 120 rats, raised until adult maturity

• 60 rats put in treatment group (enriched), 60 rats put in control group (deprived)

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- now we can compare the mean cortex weight of the enriched rats to the mean cortex weight of the deprived group

### - Potential Confounding Factors (PCFs)

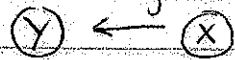
- $Z$  = potential confounding factor (genetics)

- in our experiment, genetics can influence cortex size

- PCFs are the enemy in experimental design because they create bias in the conclusions unless they are controlled for.

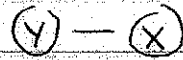
- bias - systematic tendency to over- or underestimate the truth

### Causal Diagram:

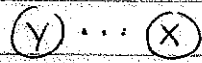


$X$  causes  $Y$

or



$X$  &  $Y$  are associated



$Z$  makes  $X$  &  $Y$  look related



positive association:  $u \uparrow, v \uparrow$

negative association:  $u \uparrow, v \downarrow$

- valid - if it tends to get the right answer on average across many repetitions if it has no bias

### • To Defeat a PCF:

1) At design time

- randomly assign subjects to treatment and control, this will break link between  $Z$  and  $X$

- hold it constant in comparison between  $T$  and  $C$ ,

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randomization does this, but there's a better way.

## 2) Matched Pair Design

- use genetically pure strain of rats
- choose 60 litters at random
- choose 2 rats at random from each litter
- assign T and C status in each pair at random
- \* more accurate, but more work