HUMAN-COMPUTER INTERACTION

EXPERIMENTAL DESIGN

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WHAT IS A HYPOTHESIS?

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HYPOTHESIS

hypothesis |hīˈpäθəsis|

noun (pl. **-ses** |-ˌsēz|)

a supposition or proposed explanation made on the basis of limited evidence as a starting point for further investigation : professional astronomers attacked him for popularizing an unconfirmed hypothesis.

• *Philosophy* a proposition made as a basis for reasoning, without any assumption of its truth.

ORIGIN late 16th cent.: via late Latin from Greek **hupothesis 'foundation,'** from **hupo 'under' + thesis 'placing.'**

HYPOTHESES

A statement of the predicted or expected relationship between at least two variables

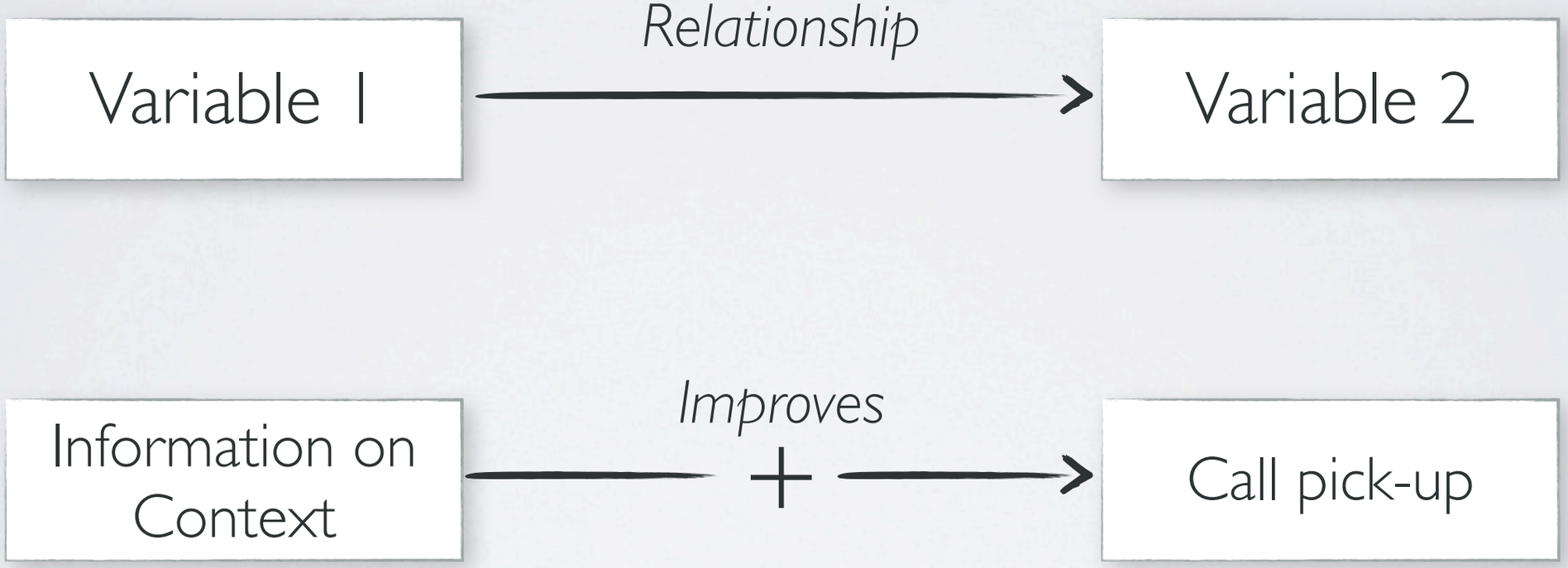
- A provisional answer to a research question
- Has to define the variables involved
- Has to define a relationship

Example:

Question: How does having information on the context of a caller affect whether the receiver picks up the call?

Hypothesis: Receivers will be more likely to pick up a call when they have information of their callers' context than they will be when they do not.

HYPOTHESES


Variable 1
Relationship
Variable 2
Information on Context
Improves
+
Call pick-up

GOOD HYPOTHESIS FORMATION

Testable: The means for manipulating the variables and/or measuring the outcome variable must potentially exist

Falsifiable: Must be able to disprove the hypothesis with data

Parsimonious: Should be stated in simplest adequate form

Precise: Should be specific (operationalized)

Useful:

Relate to existing theories and/or "point" toward new theories

It should lead to studies beyond the present one (often hard to determine in advance)

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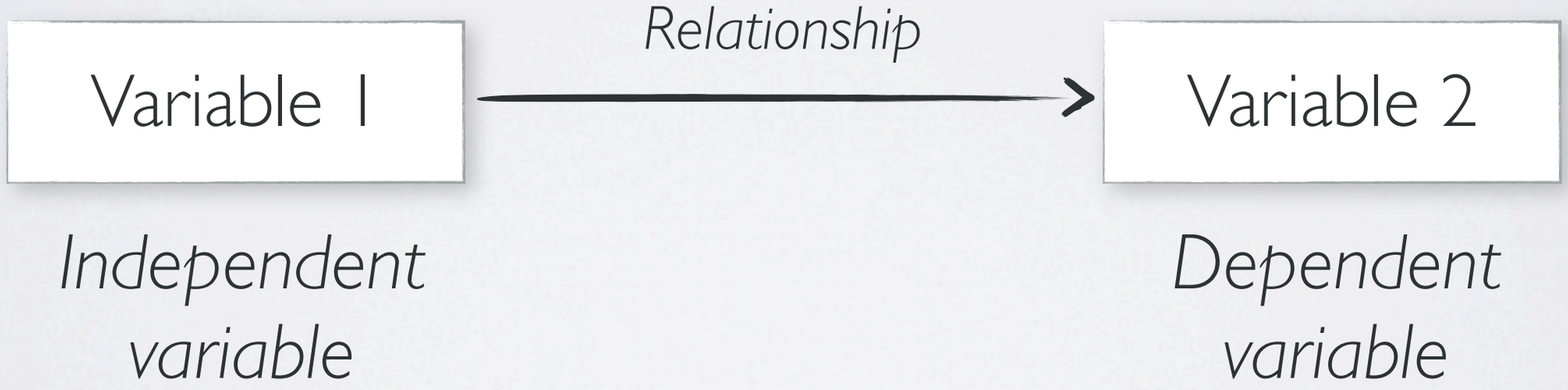
VARIABLES

Independent variable

What is manipulated

Dependent variable

What is measured



VARIABLES

Control variables

- What is held constant

Random variables

- What is allowed to vary randomly

Confounding variable

- What correlates with the independent + dependent variable

WHAT IS THE DIFFERENCE BETWEEN CAUSALITY AND CORRELATION?

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RELATIONSHIPS

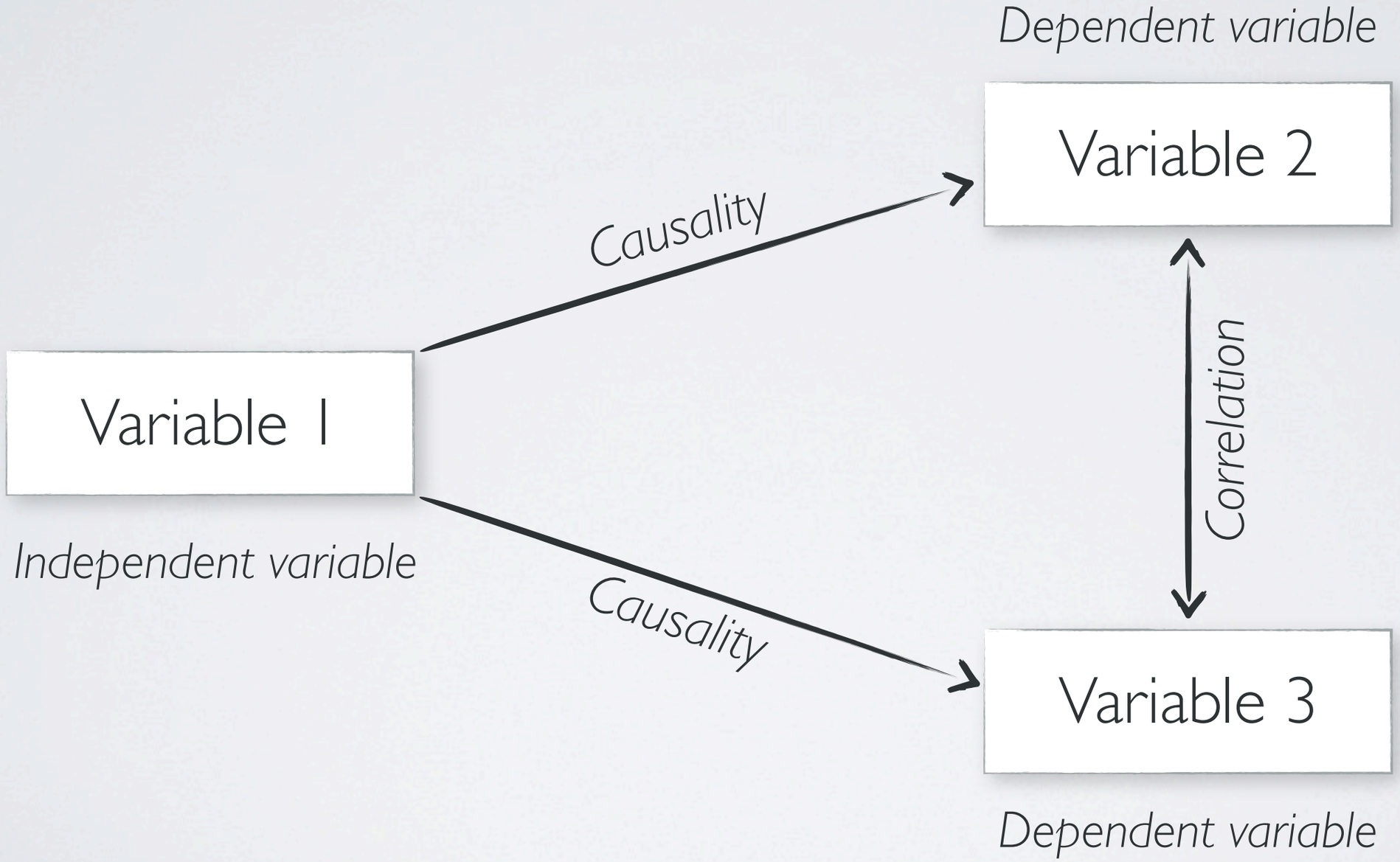
Causal

One variable depends on and is affected by the other

Correlational

Two variables are affected by a third variable in the same direction

RELATIONSHIPS



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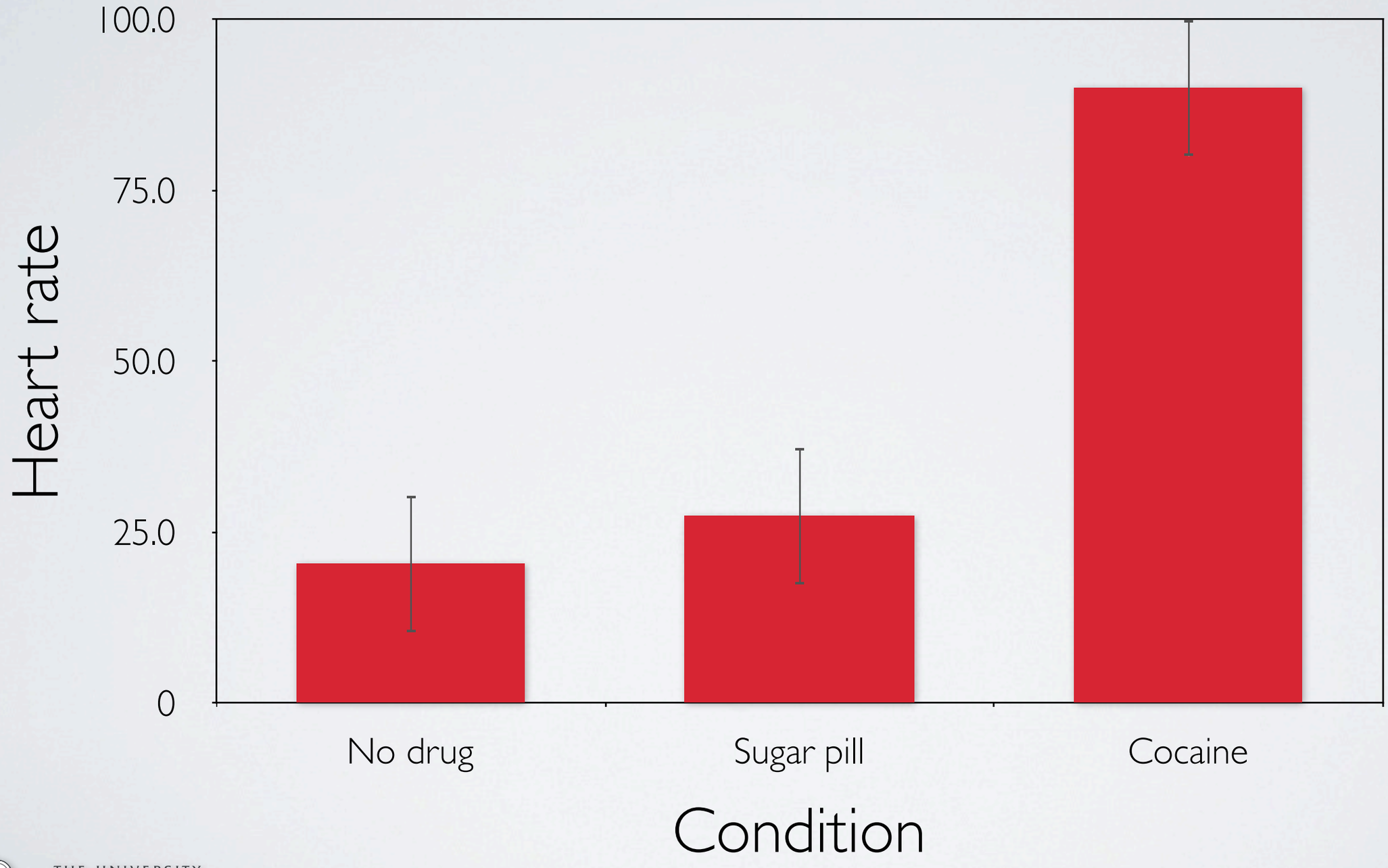
CAUSAL



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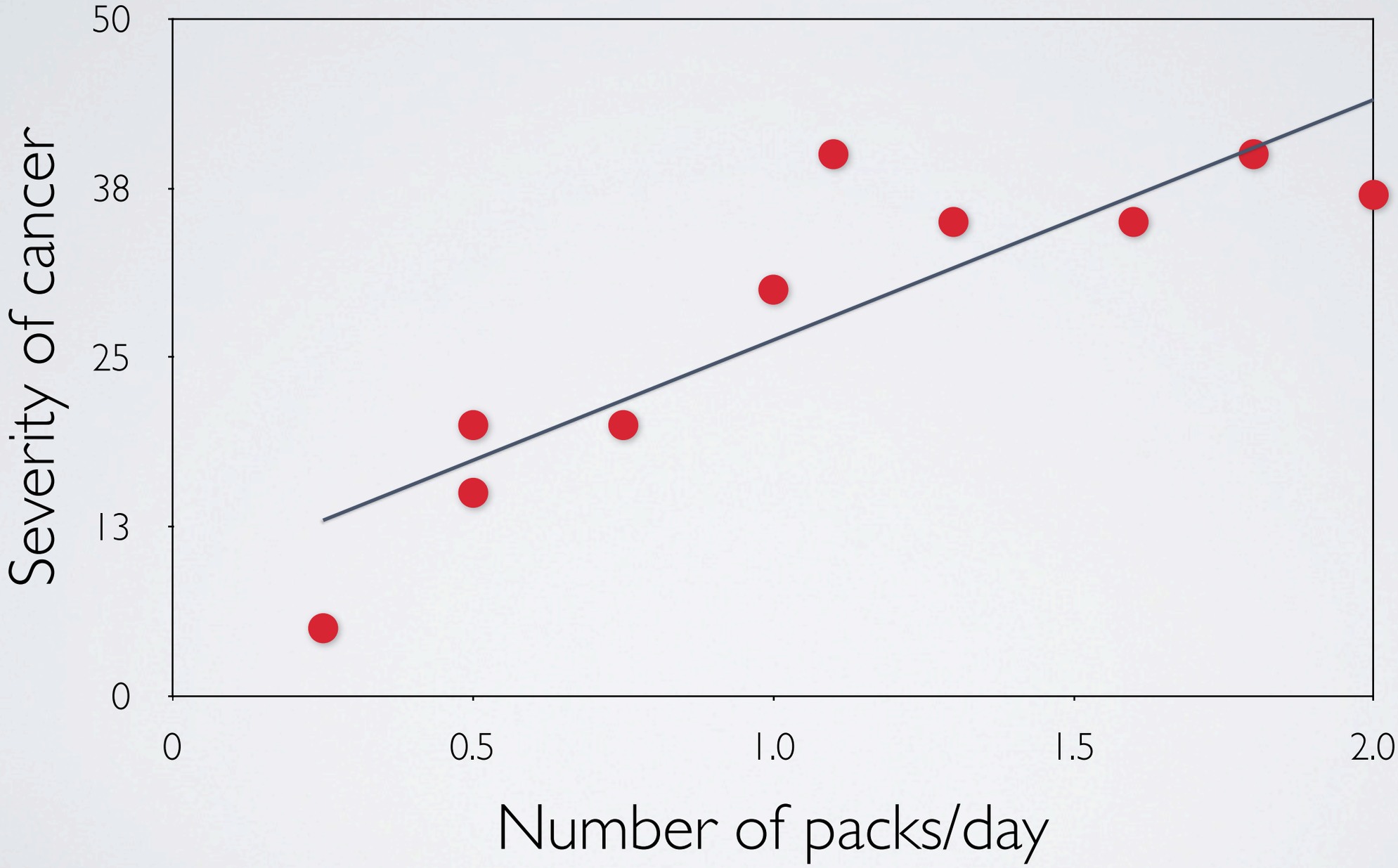
CORRELATIONAL



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EXPERIMENTAL DESIGN

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EXPERIMENTAL DESIGN

Correlational research

Quasi-experimental research

Experimental research

CORRELATIONAL DESIGN

For studies examining the relationships between variables such as personality traits, work habits, gender, etcetera, the hypothesis is a specific statement about relationships

If when we observe an increase in X then we will also observe and increase (or decrease) in Y

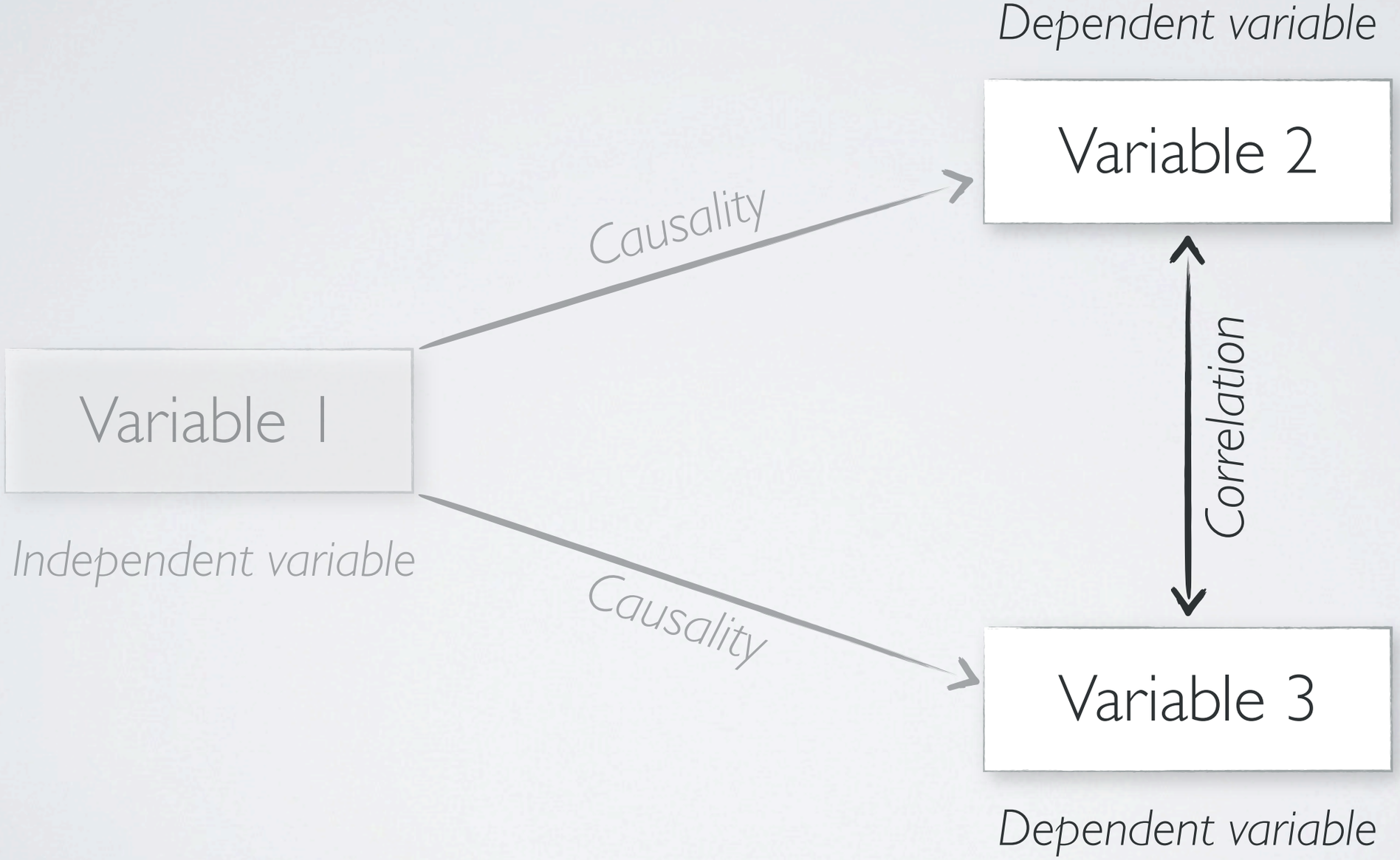
Example questions;

Is there a relationship between smoking and lung cancer?

Is there a relationship between anxiety and test-taking performance?

Correlation does NOT imply causation

CORRELATIONAL DESIGN



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QUASI-EXPERIMENTAL DESIGN

Used when randomization is impossible and/or impractical

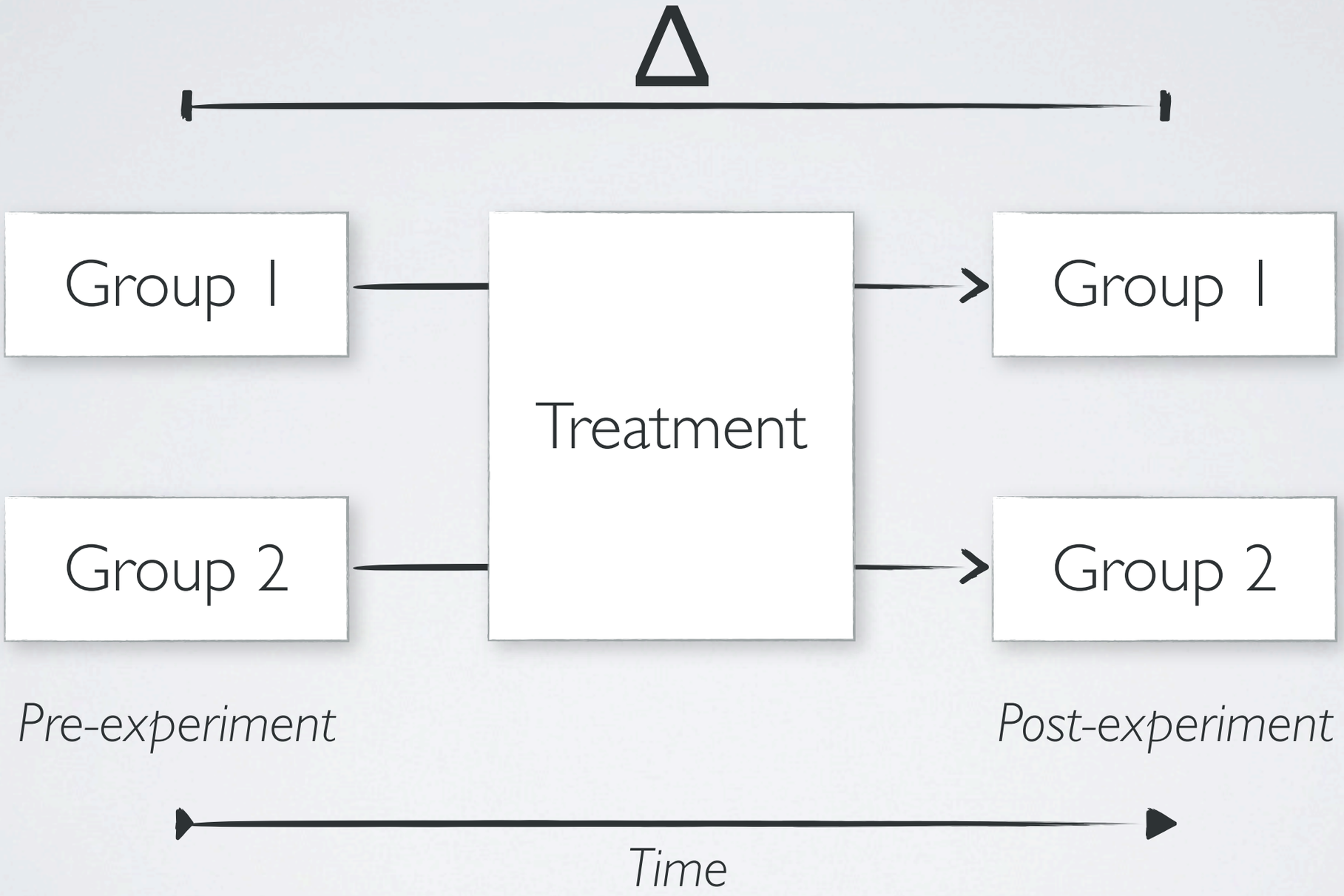
Separate participants based on some characteristic

- No random assignment
- E.g., Gender, occupation, verbal ability (VSAT)

Possible questions

- Do people with high verbal ability learn new languages faster?

QUASI-EXPERIMENTAL DESIGN



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TRUE EXPERIMENTAL DESIGN

Studies in which variables are manipulated and outcomes measured, the hypothesis is a cause and effect statement

Y will occur, when X is manipulated

Examples

Students will remember more items from a word list if they learn the list in the quiet, rather than in the presence of intense music

Reading speed (words/minute) will change when font size is manipulated, such that reading speed will increase as font size is increased from 4 point to 20 point, but reading speed will decrease as font size is increased above 20 point

NUMBER OF VARIABLES

Single Variable

- Only one independent variable
- Cannot look at interactions

Multiple Variables

- Two or more independent variables
- If use **factorial design**, can look at interactions
- Will require more participants (between) or time (within)

WITHIN VS. BETWEEN DESIGNS

Comparisons between conditions **within** participants

- Demands time
- Statistical power with smaller number of participants

Comparisons between conditions **across** participants

- Demands larger sample
- Avoids transfer effects
- Easier to avoid bias

FACTORIAL DESIGN

Suppose we are interested in the effect of both how gaming and computer use affect perception of robots

Ideally: look at all 4 populations in one experiment

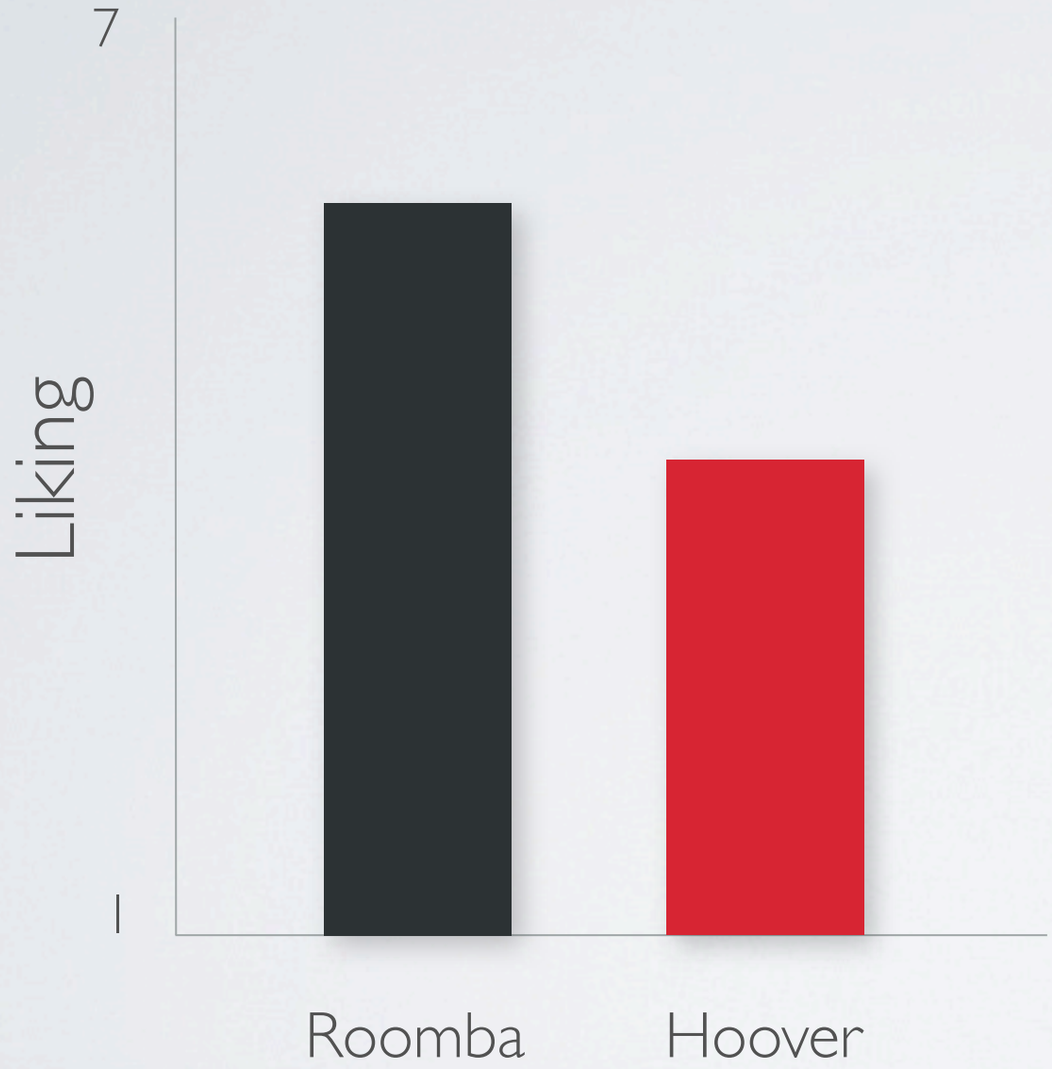
High/Low computer use x Gamer/Non-Gamer

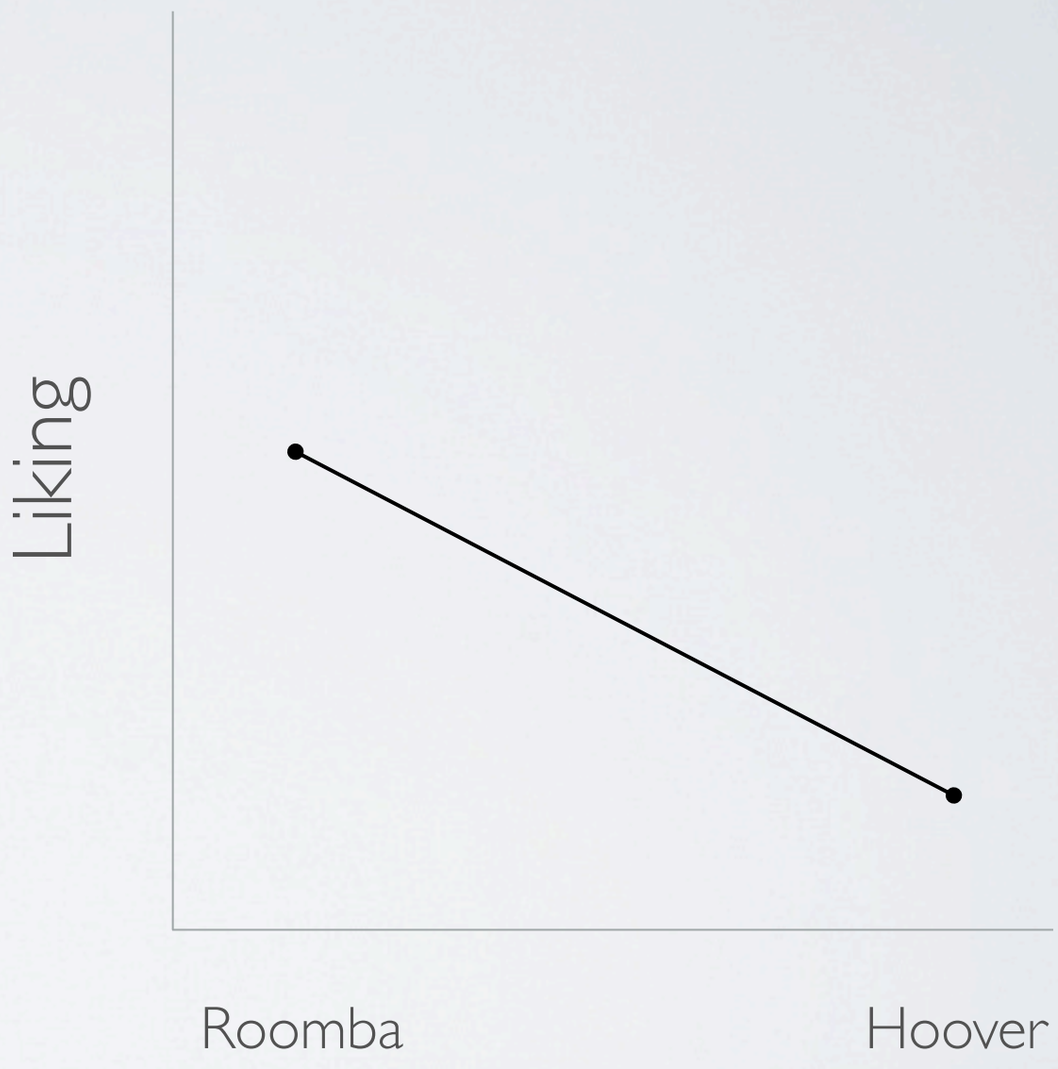
Why?

We can learn more

More efficient than doing numerous single-factor experiments

MAIN EFFECTS





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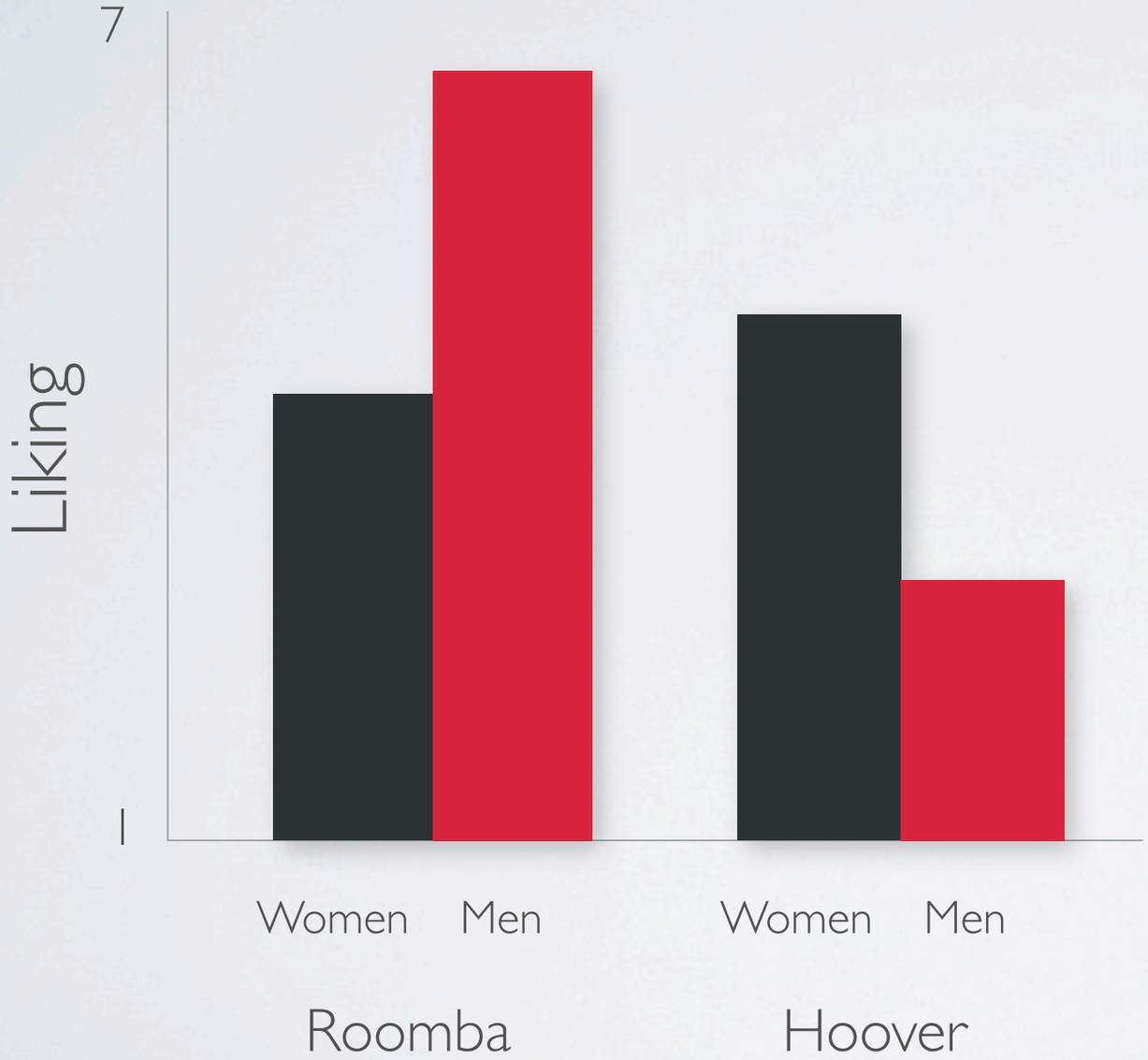
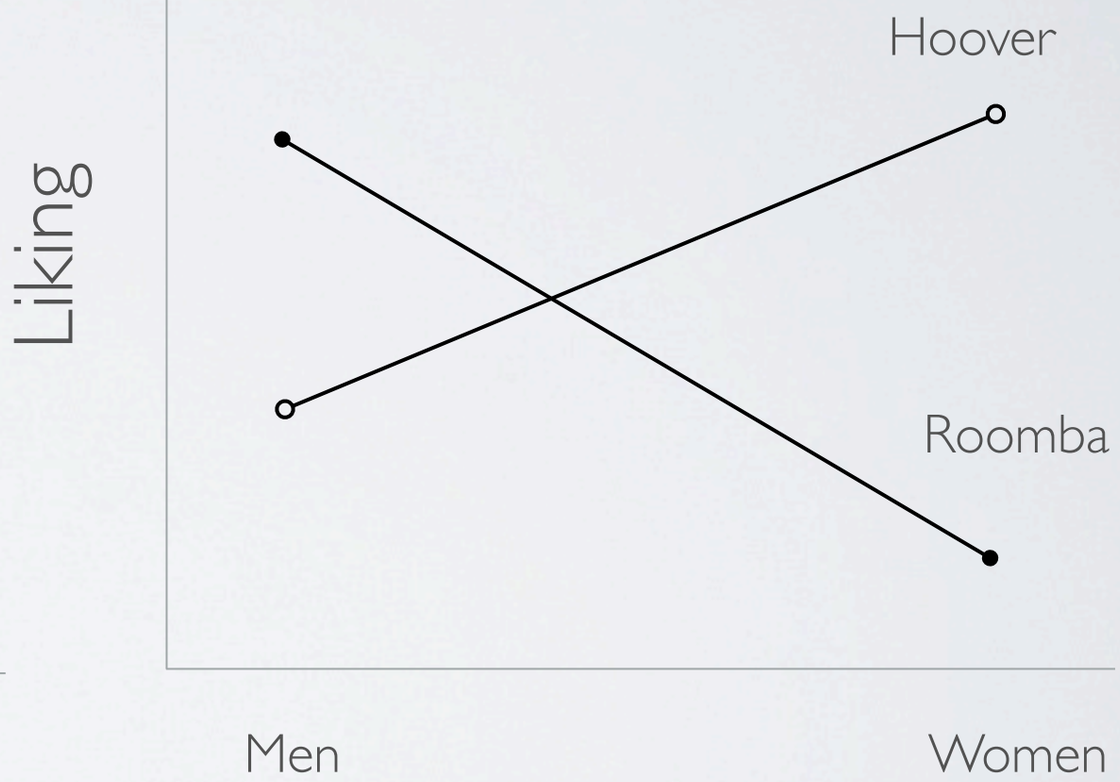
INTERACTION EFFECTS





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RANDOM SAMPLING

Random Sampling

- Choose participants randomly from the entire population
- Allows generalization to population
- Randomization allows the later use of probability theory and gives a solid foundation for statistical analysis
- Avoid bias
  - The first six students who come in the lab might be highly motivated

Random Assignment

- Random does not mean haphazardly
- One needs to explicitly randomize
  - Random assignment at arrival, counterbalancing, matching

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COUNTERBALANCING

Particularly important in **within** designs

Important because of **transfer effects**

- Taking part in earlier trials changes performance in the later trials
  - Due to learning, fatigue, etc.

Makes within-subjects designs difficult to interpret

COUNTERBALANCING

In within-subjects counter-balancing:

Possible **linear transfer effects**

Is the transfer from the 1st position to the 2nd position the same as the transfer from 2nd to 3rd position?

E.g., sometimes most learning happens in 1st trials

Always worry about asymmetrical transfer

Does A influence B more than B influences A?

COUNTERBALANCING

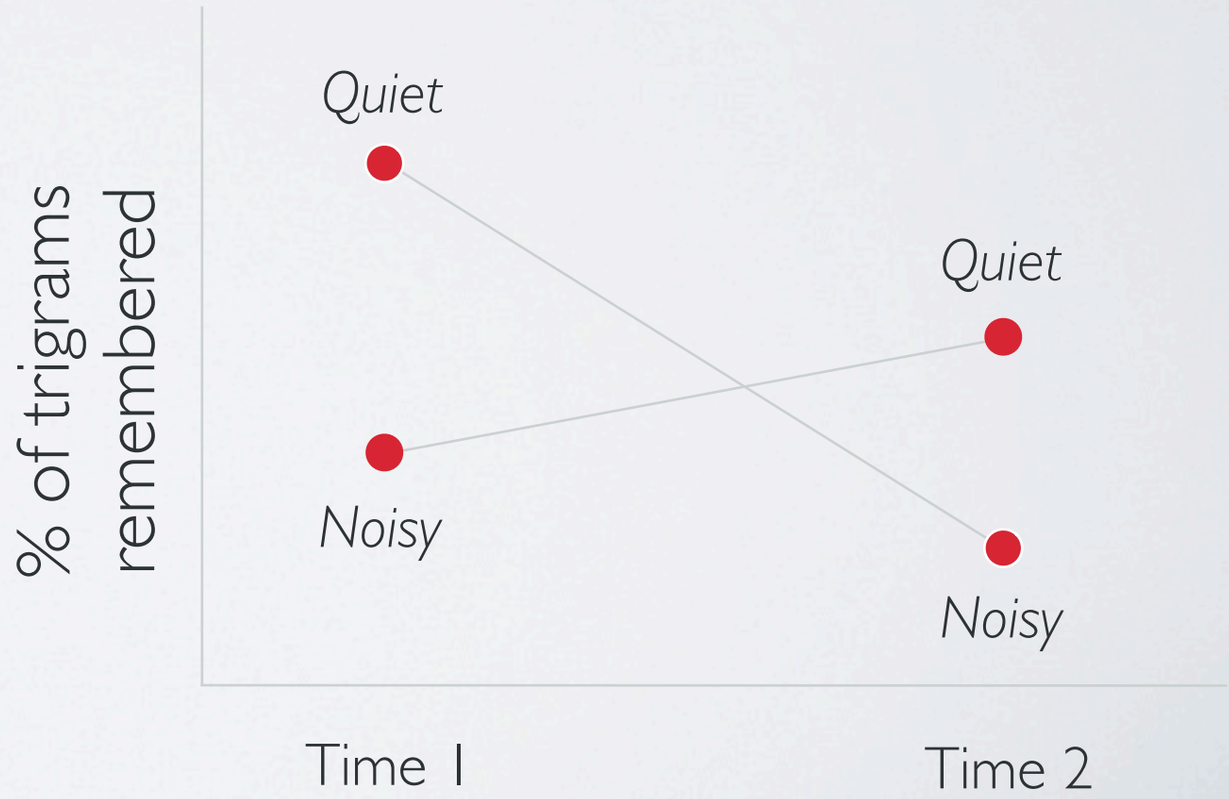
Asymmetrical transfer

Effect of noise depends on order

People stick with the strategy they pick first

Or mix strategies

Use a between design



COUNTERBALANCING

Partial counterbalancing

Latin square

Every condition appears in every position equally:

Joe:	A	B	C
Mary:	C	A	B
John:	B	C	A

MATCHING

Try to reduce between-group differences

E.g., rank hearing as Good, Fair, Poor

Unmatched, could get;

Noisy: Poor1, Poor2, Fair1

Quiet: Good1, Good2, Fair2

Matched, get:

Noisy: Poor1, Fair2, Good1

Quiet: Poor2, Fair1, Good2

STRATIFICATION

Suppose that some social measurements will be made in the morning and some in the afternoon

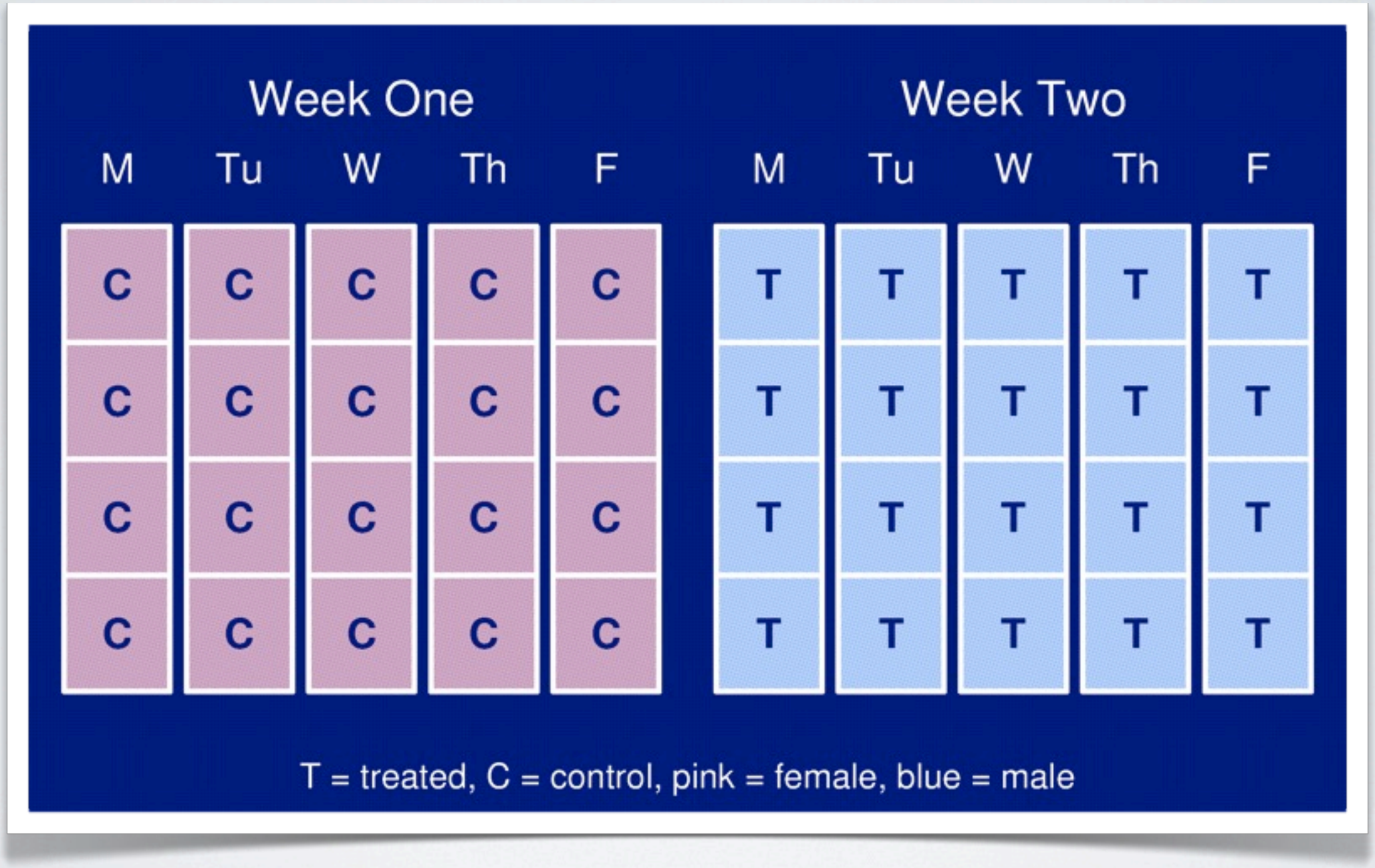
If you anticipate a difference between morning and afternoon measurements:

Ensure that within each period, there are equal numbers of subjects in each treatment group

Take account of the difference between periods in your analysis

This is sometimes called "blocking"

VERY BAD DESIGN



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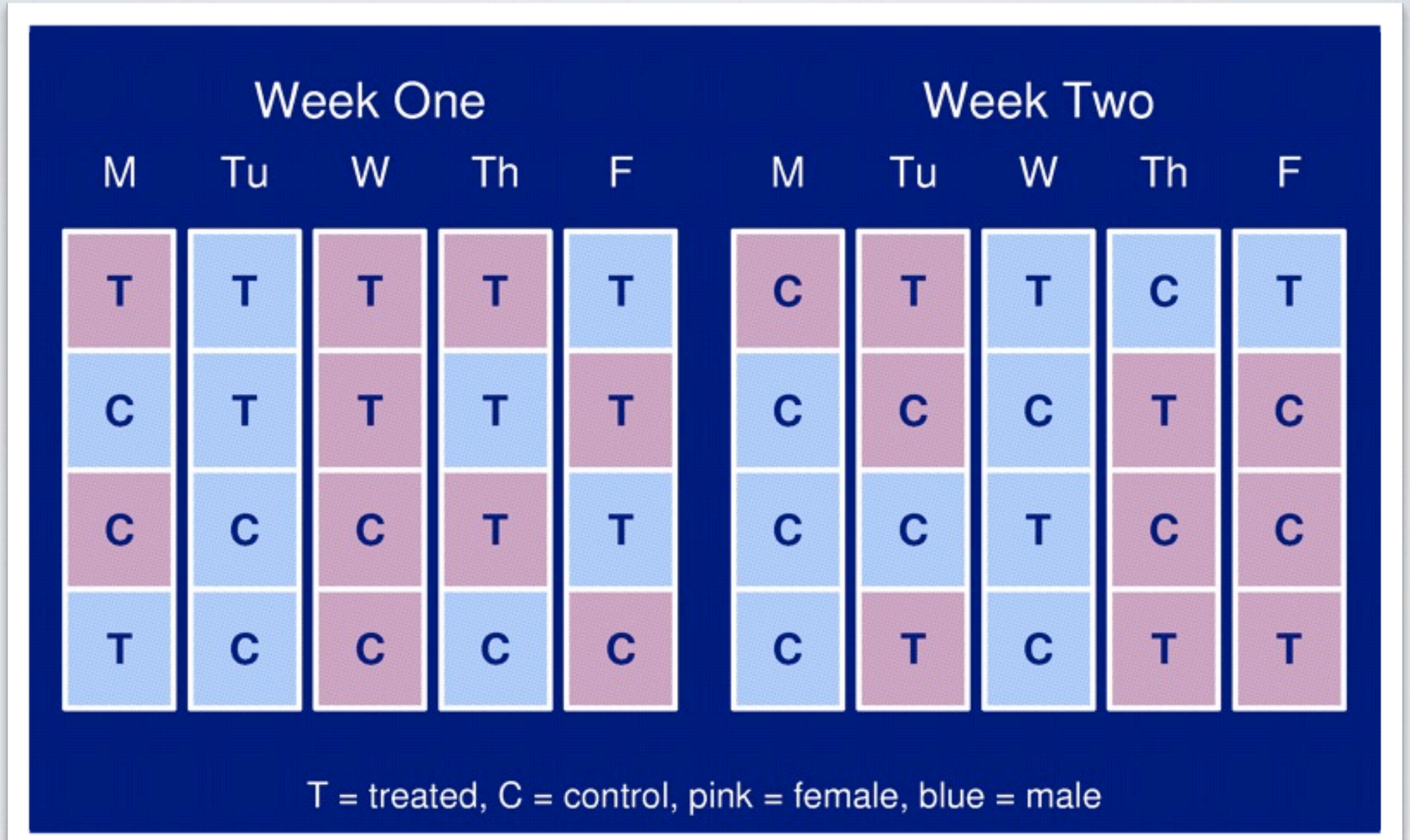
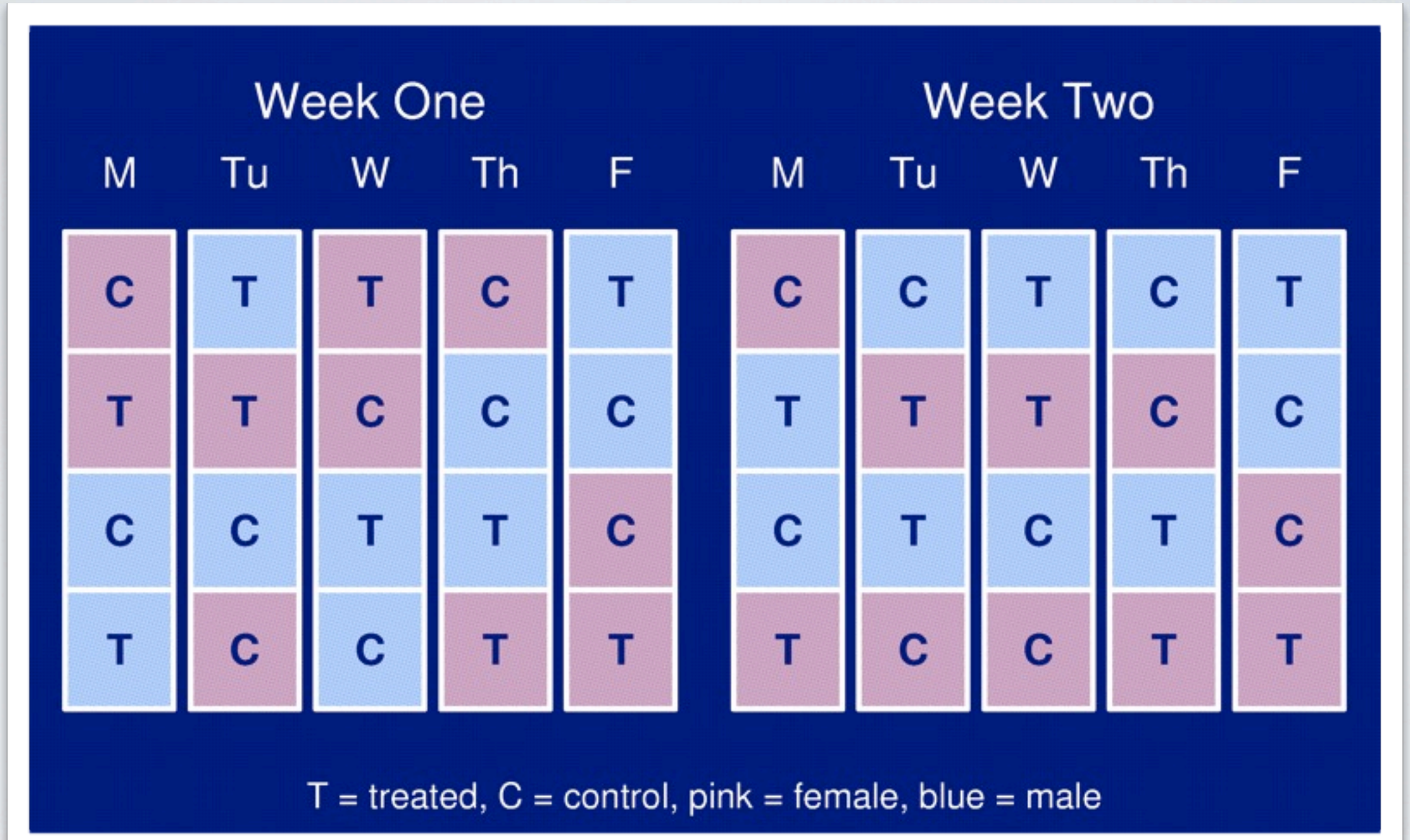
RANDOMIZED


Week One
M Tu W Th F
T T T T T
C T T T T
C C C T T
T C C C C
Week Two
M Tu W Th F
C T T C T
C C C T C
C C T C C
C T C T T
T = treated, C = control, pink = female, blue = male

STRATIFIED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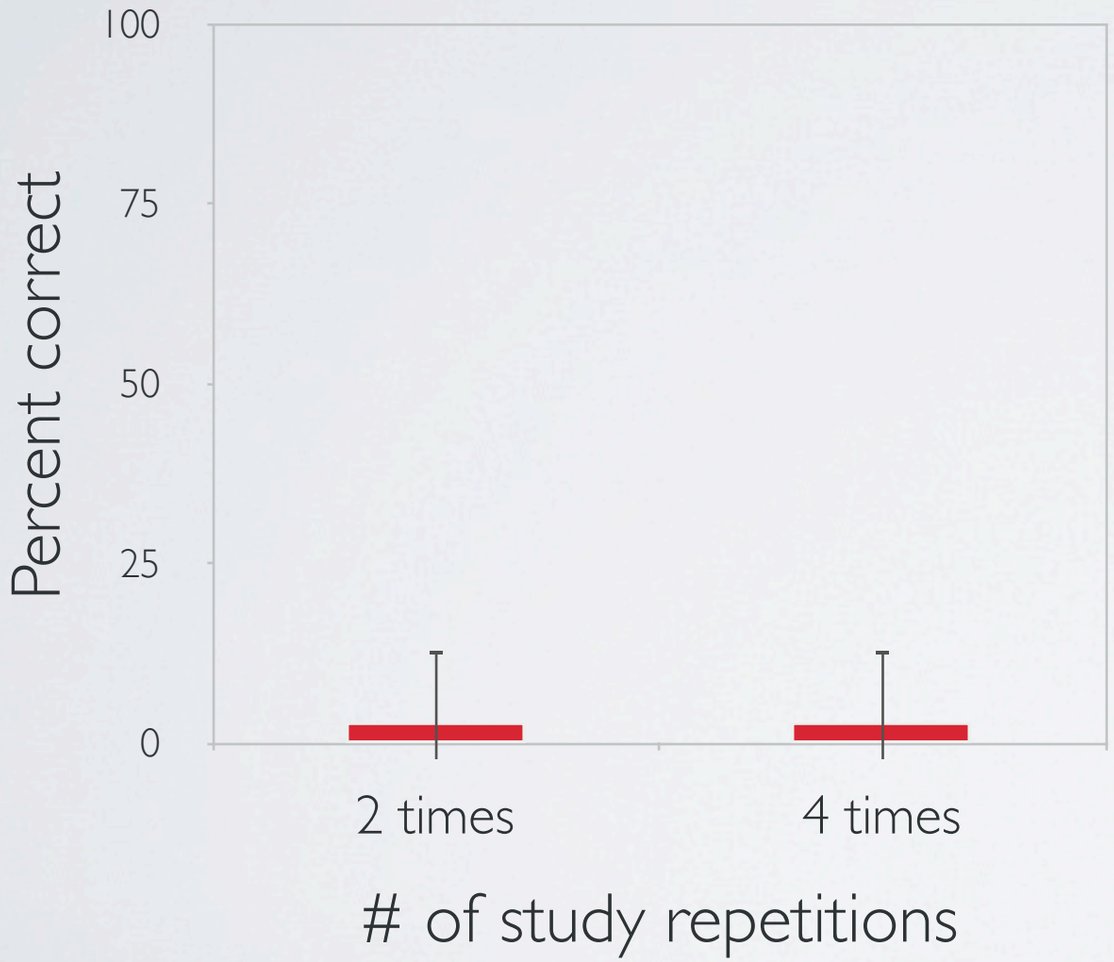
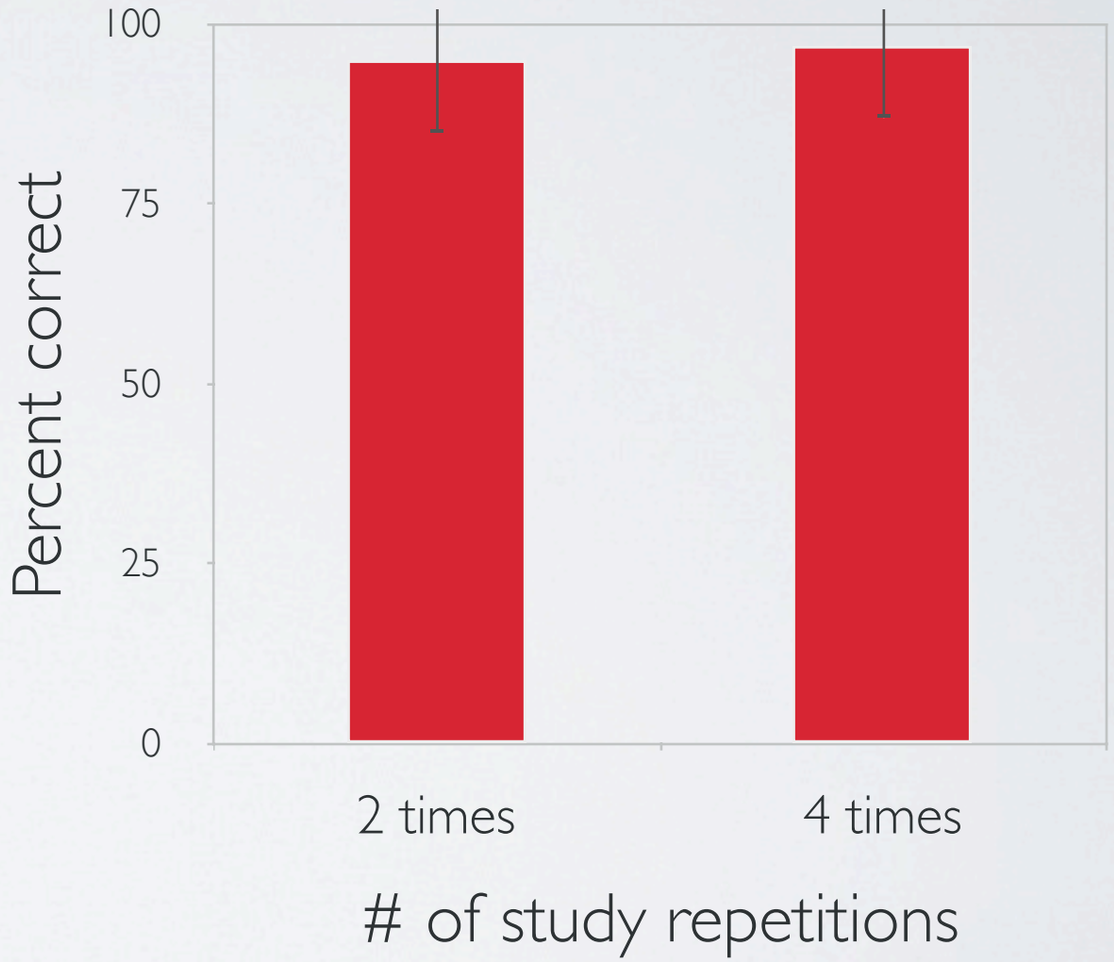
FLOOR AND CEILING EFFECTS





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BLINDING

Blinding

- Measurements made by people can be influenced by unconscious biases
- Ideally, dissections and measurements should be made without knowledge of the treatment applied
- Single vs. double-blind designs

Internal controls

- It can be useful to use the subjects themselves as their own controls (e.g., measuring the response after vs. before treatment)
- Increased precision

REPRESENTATIVENESS

Are the subjects you are studying really representative of the population you want to study?

- Ideally, your study material is a random sample from the population of interest.

SUMMARY

CHARACTERISTICS OF GOOD EXPERIMENTS

- Unbiased
  - Randomization
  - Blinding
- High precision
  - Uniform material
  - Replication
  - Blocking
- Simple
- Protect against mistakes
- Wide range of applicability
  - Deliberate variation
  - Factorial designs
- Able to estimate uncertainty
  - Replication
  - Randomization

QUESTIONS?

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