Experiments and Observational Studies

Chapter 11

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Music and Good Grades

The Study:

- Compared GPAs of music students and non-music students at Mission Viejo High School.

The Results

- Music Students: 3.59
- Non-Music Students: 2.91

Conclusions

- Should we make all students play an instrument?

Issues

- Could there be something else resulting in both?

Observational Studies

- Researchers don't assign choices.
- Passively observe participants
- Good for discovering relationships related to rare outcomes
- Bad for establishing cause-and-effect relationships
- Tough to handle lurking variables
- Do musicians have more supportive parents that help GPA?
- Are smarter people more inclined to play an instrument?

Retrospective Studies

- Collect data on something that has already occurred
- Similar pros and cons as observational studies
- Additional issues can include:
- Unreliable memories
- Incomplete historical records
- Often limited to a small part of the population

Prospective Study

A prospective study is a study where we identify subjects in advance and collect data as events unfold.

Pros:

- Possible to isolate the variables.
- With care, can establish cause and effect.
- Can design the study to your specifications.

Cons:

- Can be expensive.
- Rare occurrences require very large samples.
- Can take too long: Do breast-fed babies live longer than bottle-fed?

Experiments

Is it possible to establish a cause and effect relationship?

- Take 100 young children. Randomly select 50 to be in a music program. The other 50 will not be allowed to play an instrument.
- An experiment requires random assignment of subjects to treatments.
- Only experiments can establish cause and effect.

How Experiments Work

- Identify the explanatory variable(s), called the factor(s).
- Identify the response variable.
- Select subjects or participants (if human) or experimental units (if not human).
- Decide on the levels to choose for each factor.
  - Music program or no music program
  - Sleep hours: 4, 6, or 8
- The combination of specific levels from all factors that a subject receives is called its treatment.

Assigning Participants to Treatments

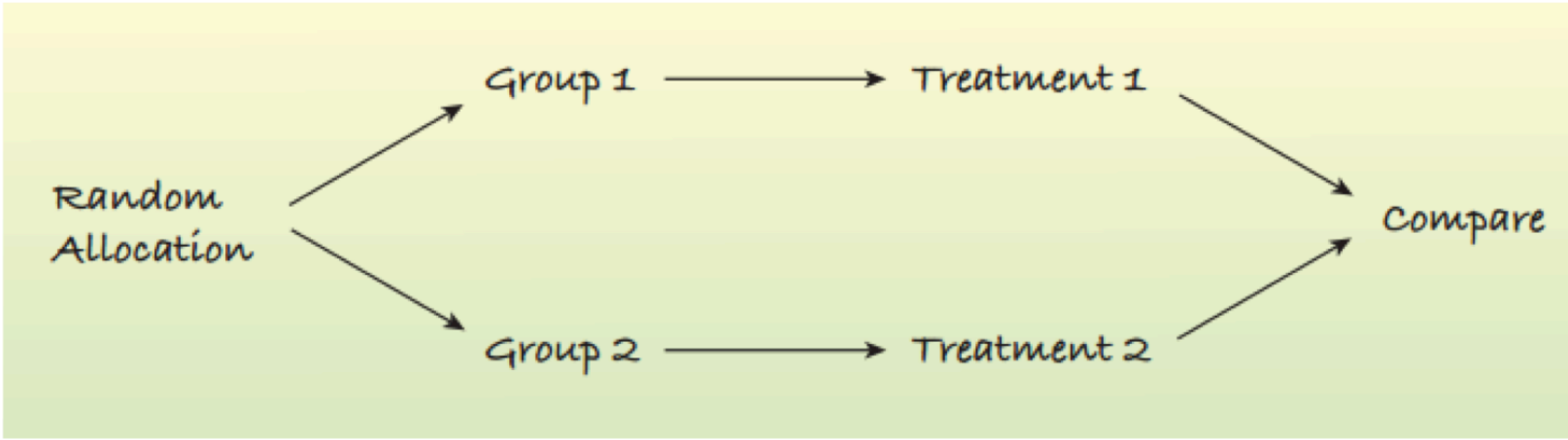
- Don’t let them choose.
- Don’t assign based on what’s best for each.
- Randomly assign participants into groups. Each group receives a different treatment.
- Only through random assignment can a cause-and-effect relationship be established.
- What ethical dilemmas might this introduce?

The Four Principles of Experimental Design

1. Control
    - Make all conditions as similar as possible for all treatment groups.
    - Control allows us to isolate the one thing that is being studied. Helps avoid lurking variables
2. Randomize
    - Equalizes the effects of variation that we cannot control
    - Distributes the uncontrollable factors equally
    - Control what you can, randomize the rest.

The Four Principles of Experimental Design (cont.)

1. Replicate
    - Apply each treatment to a number of subjects.
    - Repeat the entire experiment on an entirely different population of experimental units.
2. Block
    - Group similar individuals together and randomize within each of these blocks.
    - Blocking helps account for the variability due to the difference between blocks.


Random
Allocation
Group 1
Group 2
Treatment 1
Treatment 2
Compare

Statistical Significance

A difference is called statistically significant if the difference is greater than what we would expect from random chance.

Flip a coin 100 times:

- 52 tails is not statistically significant since it would not be surprising to observe this outcome.
- 93 tails is statistically significant since it would be surprising to observe this outcome.

Random Samples and Random Treatments

- Surveys use a random group of participants.
- Experiments find a homogeneous group, separate them into random subgroups for treatment.
- Experiments do not use a random sample from the population.
- Beware of stating that the participants from the experiment represent the larger population.

Blinding

What brand of cola is the best?

- If you give participants cans of cola and ask how much they like it, the label can be an influence.
- Instead give each an unlabeled cup of soda.
- Single-blinding involves the participants not knowing whether they are in the control or treatment group.
- If the person handing out the cups hands out her favorite soda she may bias the results.
- Double-blinding means neither the participant nor the person handing out the soda knows the label.

Who Can Affect the Experiment

There are two main classes of individuals who can affect the experiment.

Those who can influence the results.

- Subjects
- Treatment administrators
- Technicians

Those who evaluate the results.

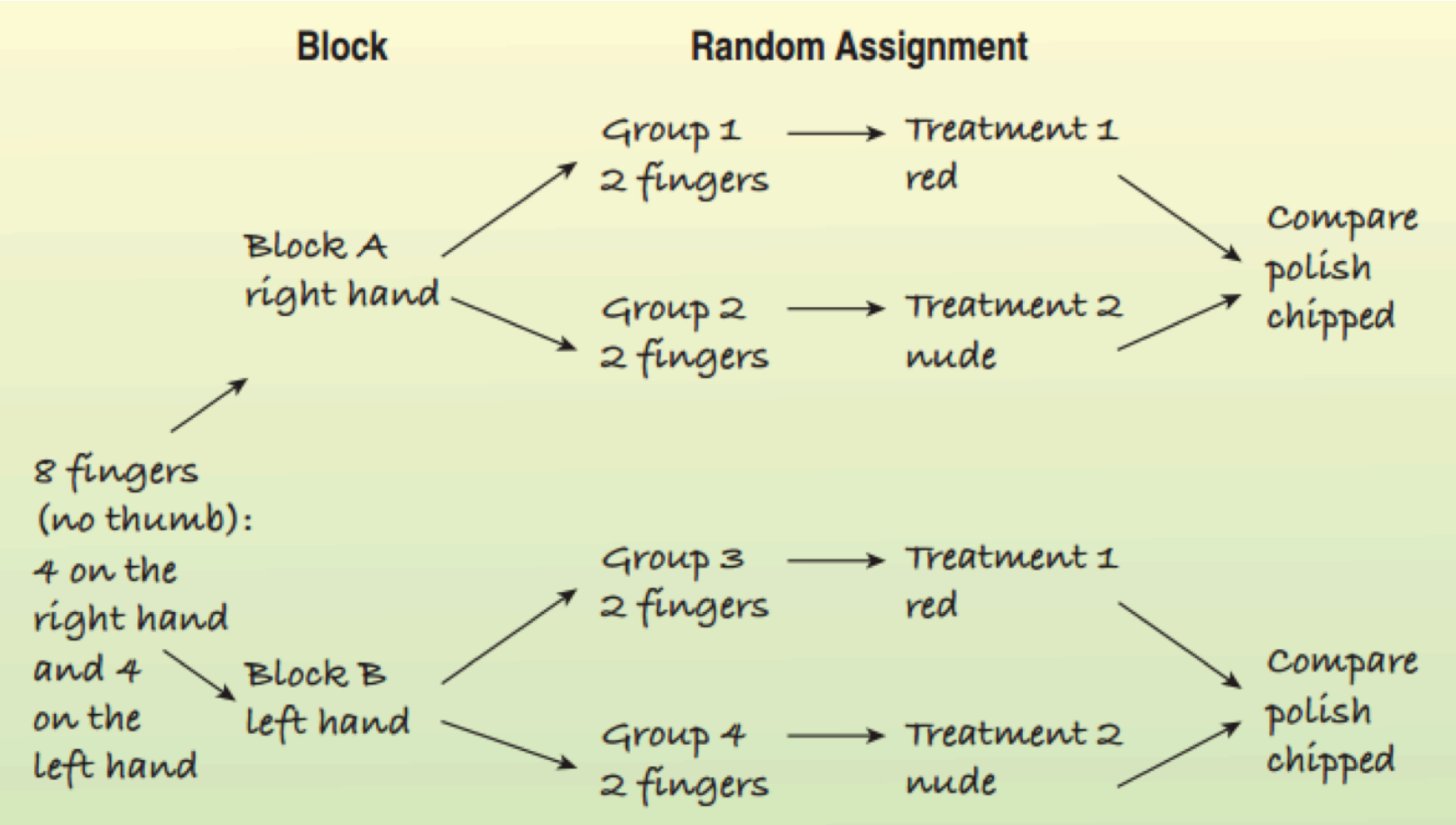
- Judges
- Treating Physicians

Placebos

- A placebo is a “fake” treatment that looks like the treatment being tested.
- Just telling a patient that they are being treated can aid recovery.
- This is called the placebo effect.
- Use a placebo for effective blinding.

Blocking

- Experimental units can be separated into groups that are not the treatment, we call these groups blocks.
- Blocking involves randomly assigning the treatments within each block.
- Blocking helps isolate the variability due to the differences between blocks.
- Blocking helps clarify the difference between the treatments.
- The design is called a randomized block design.


Block
Random Assignment
8 fingers (no thumb): 4 on the right hand and 4 on the left hand
Block A right hand
Block B left hand
Group 1 2 fingers
Group 2 2 fingers
Group 3 2 fingers
Group 4 2 fingers
Treatment 1 red
Treatment 2 nude
Treatment 1 red
Treatment 2 nude
Compare polish chipped
Compare polish chipped

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Animated Teaching vs. Subdued Teaching

Professor Ceci taught the same course in the fall and the spring.

- Fall: Subdued manner, everything else the same
- Spring: High enthusiasm, animated gestures

Results: How much did you learn? (1-5)

- Fall: 2.93
- Spring: 4.05

Conclusions

- Animated teaching better than subdued teaching???
- Weather: Fall ends gloomy, spring ends pleasant.

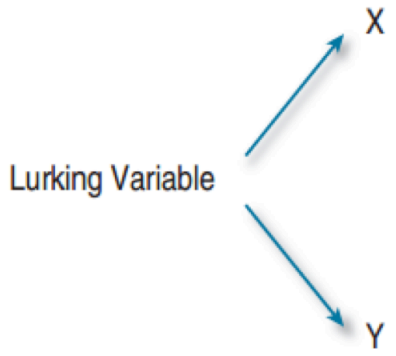
Confounding Factors

- Two factors are confounded if the levels of one are associated with the levels of the other.
- Weather and Professor Cecil's style were confounded.
- Try to avoid confounding factors, but it is difficult and sometimes impossible.
- Avoiding confounding factors can introduce new ones.
- Compare morning and afternoon fall courses.

Lurking and Confounding

Lurking Variable

- Associated with both x and y
- Makes it appear that x causes y



Confounding Variable

- Associated in a noncausal waywith a factor
- Affects the response
- Can't tell if the cause was the factoror confounding variable