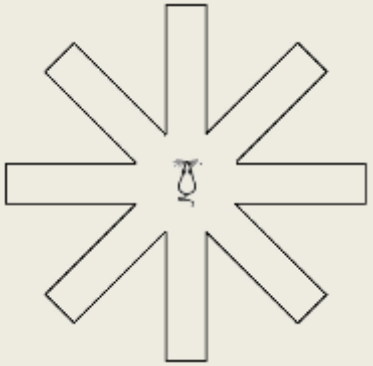
How to do Experiments

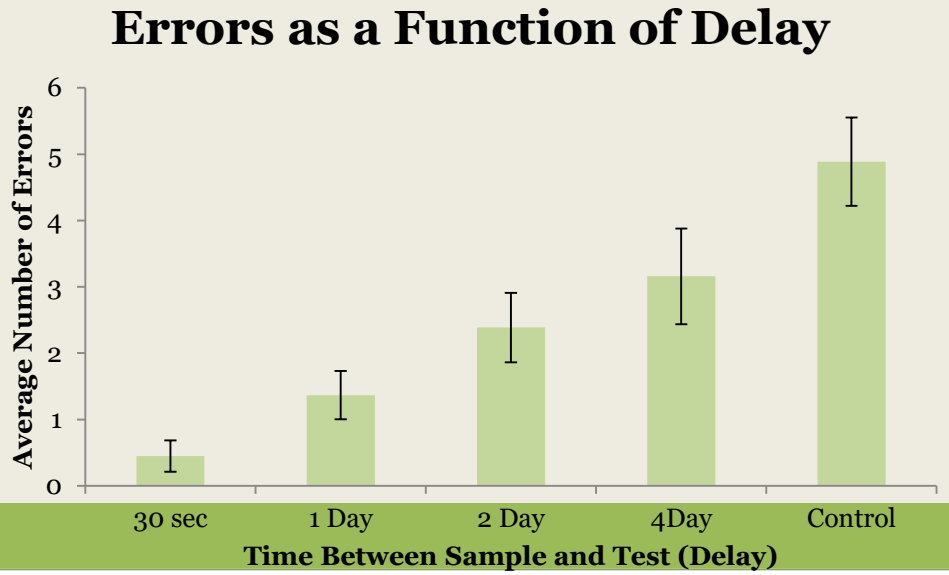
Experiments

- What an Experiment Should do:
  - **Test whether a hypothesized cause does in fact produce the hypothesized effect.**
- How an Experiment Can do This:
  - Randomly assign the conditions
  - Measure everything well and in the same way
  - Make sure nothing that is not part of the intended conditions corresponds with the condition

Example Experiment

- Suppose we train rats to find a particular end of a maze with a reward.
- Then we vary how long after the training they get tested.
- We can randomly assign each rat to each amount of test delay.

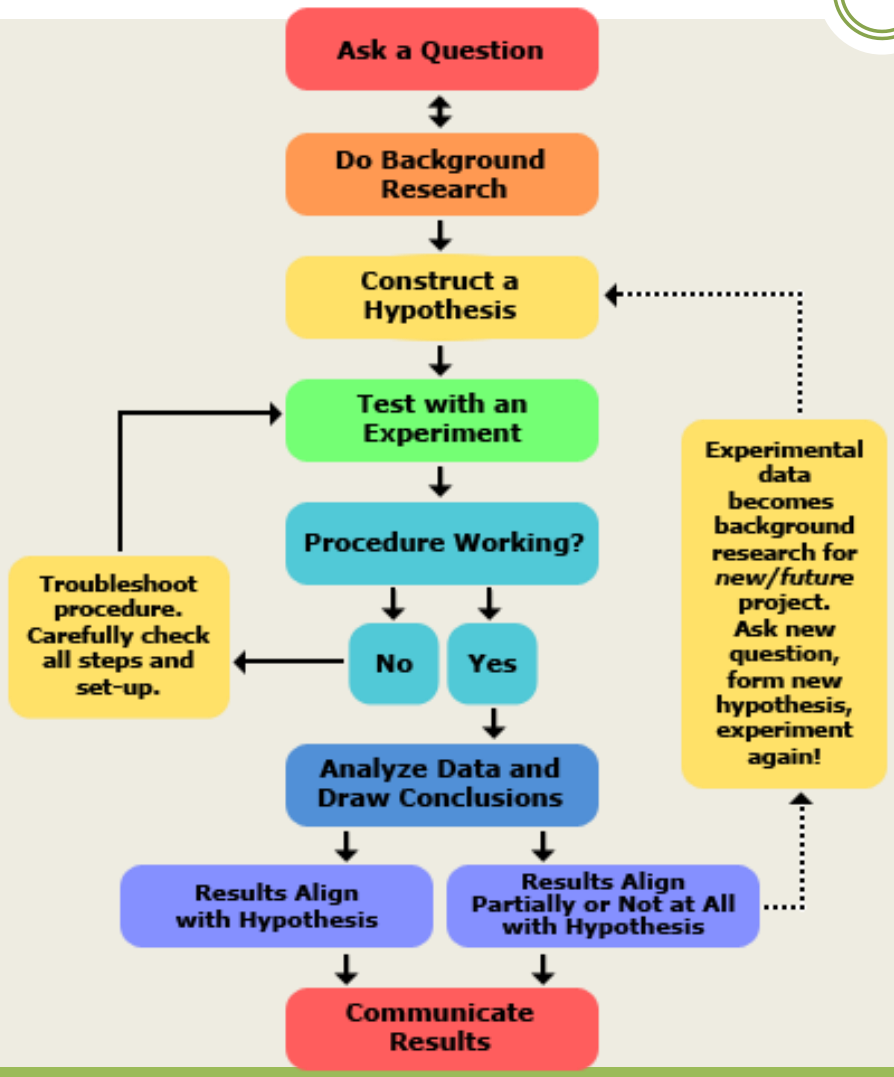




Terms

- Scientific Method
- Hypothesis
  - H_1 and H_0
- Independent Variable (IV)
- Dependent Variable (DV)
- Confounding Variables
- Control Variables
  - Placebo
  - Control Group
  - Blindedness
- Validity
- Variability
- Within-Subjects Design
- Between-Subjects Design
- Mixed-Design
- Subject
- Population
- Sample
- Randomization

Psychological Research: Scientific!



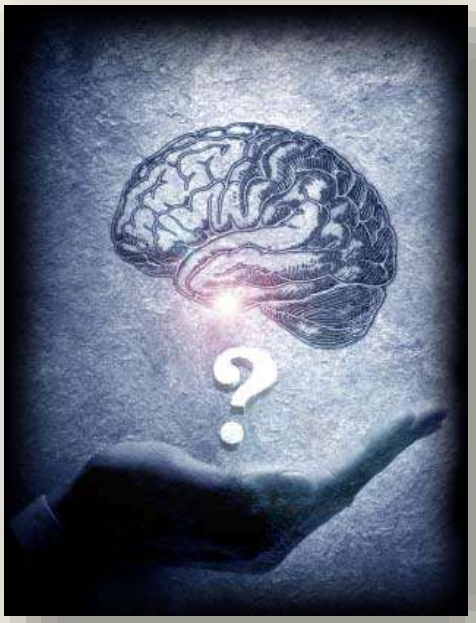
Good research uses the **scientific method** to **empirically test** hypotheses

Recap of Scientific Method

- Ask a question
  - Often drawn from observation
  - What is it that you want to know? The more specific, the better!
- Conduct background research
  - Journal articles, books, previous studies, consult experts, etc.
- Construct a hypothesis
  - What do you expect to happen? Again, be specific!
- Test hypothesis by conducting experiment
- Analyze data
- Draw conclusions
- Communicate results
  - How? Any ideas?

What's a Hypothesis?

- Hypothesis
  - A statement that explains or makes generalizations about a set of facts or principles, usually forming a basis for possible experiments to confirm its viability.



Research question: *Does an unhealthy diet lead to obesity?*

Example hypothesis: *Rats who eat sugary foods will be heavier than rats who eat a balanced diet.*

Is this testable??

Independent Variables

- Independent Variable
  - An independent variable (IV) is controlled by the experimenter, meaning:
  - The researcher designs different “levels” (or a set of categories, actually) of this variable as conditions, and then randomly puts different participants into each condition.
  - Random assignment (plus no confounds) is what allows researchers to make causal conclusions from experiments.

Independent Variables

- What is the independent variable in the following example?
  - Some rats are supplied with rat chow, some with cookies, and some with dog chow.

DIET—the experimenter manipulates what each group of rats eats

Dependent Variable

- Dependent Variable (DV)
  - A measure of the *consequence* of the independent variable. (This is sometimes also called an outcome variable).

We might want to measure, as the DV:

WEIGHT—the experimenter manipulates what each group of rats eats in order to measure how their weight is affected.

Or even Nutrients, or incidents of illness, or intelligence.

H_1

- Experimental Hypothesis (H_1)
  - A statement that explains a set of facts, principles, or previous findings.
  - The Independent Variable (IV) affects the Dependent Variable (DV).
    - In other words, *what do you expect will happen*??

E.g., Rats who eat cookies will be heavier than rats who are fed only rat kibble.

H_0

- Null Hypothesis (H_0)
  - A statement that does NOT explain a set of facts, principles, or previous findings.
  - The Independent Variable (IV) has NO effect on the Dependent Variable (DV).
    - In other words, *NO SIGNIFICANT DIFFERENCES BETWEEN GROUPS*

E.g., There will be no difference among the 3 diet conditions in rat's weight.

- (Null hypotheses are fake questions in a way – it is smarter to propose an alternative hypothesis).

Considerations about H_0

H_0 Rats who are fed only cookies DO NOT show an increase in weight compared to rats who were fed only kibble.

This can be considered a silly null hypothesis because it is pretty obvious. What might be a non-trivial hypotheses are (a) whether the cookie condition rats gain more than a certain amount of weight, (b) whether the cookie rats live longer.

- (a) would require we use a one-group t-test to compare the weight of cookie rats to some number.
- (b) would require a different (and longer-term) outcome measure.

Confounding

- Confounding Variable
  - An extraneous variable which can influence the results of an experiment by interacting with the IV or DV, but is not one of the variables of interest. (For example, what if cookie rats were fed at a different time of day than the other rats?)
  - Experiments with confounds cannot be interpreted – they are useless.



Examples of Confounding Variables

- Certain experimenters measure the rats for certain conditions, other experimenters for other conditions.
- Some conditions use one scale for weight, and other conditions use a different scale for weight.
- The experimenter feeding cookies sings sweetly, “Yum, Yum! Aren’t YOU the lucky ones” to the rats, but remarks in a disgusted voice, “How can you STAND this stuff? Sheesh!” when feeding the rat chow.
- The rats in the longest delay conditions are kept at the right of the lab, near the windows. The rats in the shorter delay conditions are kept to the left, nearer to the heater.

Threats to Internal Validity

- Experiments with confounds have no internal validity – because we can't say whether the independent variable or the confound is responsible for the effects (whether the same or different).
- Confounds defeat the whole purpose of an experiment.

Potential Threats to Validity with People

- In addition to confounding experimental conditions in ways similar to the rat example, with people, we have to guard against threats to validity by:
- Not making some conditions more unpleasant than others, or more rewarding than others, so that the proportion who drop out depends on condition.
- Not letting participants know or guess your hypothesis.
- Not letting participants know what other conditions are in the experiment.

More Threats to Validity with People

- It is also smart:
- Not to let your experimenters know what condition the participants are in.
- Not letting experimenters know or guess your hypothesis.
- Not letting them know what other conditions are in the experiment.
- To check that your measures should be believed (e.g., different coders agree, you calibrate your scale every day).

Designing Experimental Control

- Three basic conditions kinds of control conditions:
  - Placebo: A condition that seems just like the “Experimental” or “Intervention” condition but without the important “dose”
  - For example, if the Intervention condition requires that an adult read to a child, design a Placebo that has similar features, just not reading (e.g., same physical distance, talking, paying attention to child, etc.)
  - Untreated Control Groups: Give participants here something irrelevant to the Intervention condition, but having equivalencies like: same length of time, same level of difficulty, same expectations.

Placebo: A simulated treatment

- Placebos are used in drug trials
- In addition, Placebo effects occur for psychological reasons (person changes even with "Fake" Treatment)
- <u>Examples:</u>
  - *Hawthorne effect: Workers work harder after the company changes their lighting, whether the lighting is brighter or darker!*
- *People given anti-depressants that are fake start to feel better, even if they know they are not getting a real drug.*

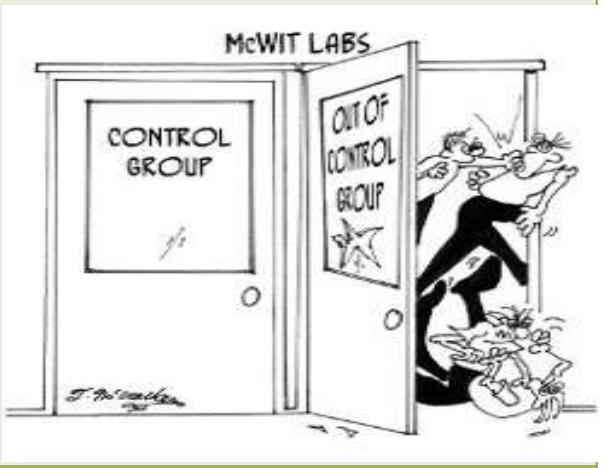
Blinded Experiments

- Blinded Experiments
  - Key information regarding the experiment is concealed from either the subjects and/or the experimenters.
  - **Single Blind Study**
    - When subjects don't know key experimental information (e.g. condition).
  - **Double Blind Study**
    - When subjects and experimenters don't know key experimental information.
- When would blinded experiments be useful? Why?

Control Group

- Control Group
  - Subjects used as a comparison to verifying the results of the experimental group.
    - The control group is not exposed to the Independent Variable (IV).
    - Therefore, the Independent Variable (IV) cannot influence the Dependent Variable (DV).

<u>Experimental Group:</u> The group that receives the IV.



ALL experiments need more than one condition

- If you don't have a condition to compare your Treatment or Intervention condition to, you don't have a benchmark or standard for comparing whether your Treatment/Intervention changed anything.

Review: Experimental Terms

- Hypothesis
  - A testable prediction or statement about how variables are related.
- Independent Variable (IV)
  - The variable that is systematically manipulated.
- Dependent Variable (DV)
  - The variable that is measured; the variable that depends on the action of another variable.
- Confounding Variable
  - Other factors, not of interest, that may affect the D./results.
- Control Measures
  - Techniques used to reduce the effects of confounding variables, ensuring that changes in the DV are due to manipulation of the IV

Subjects/Participants

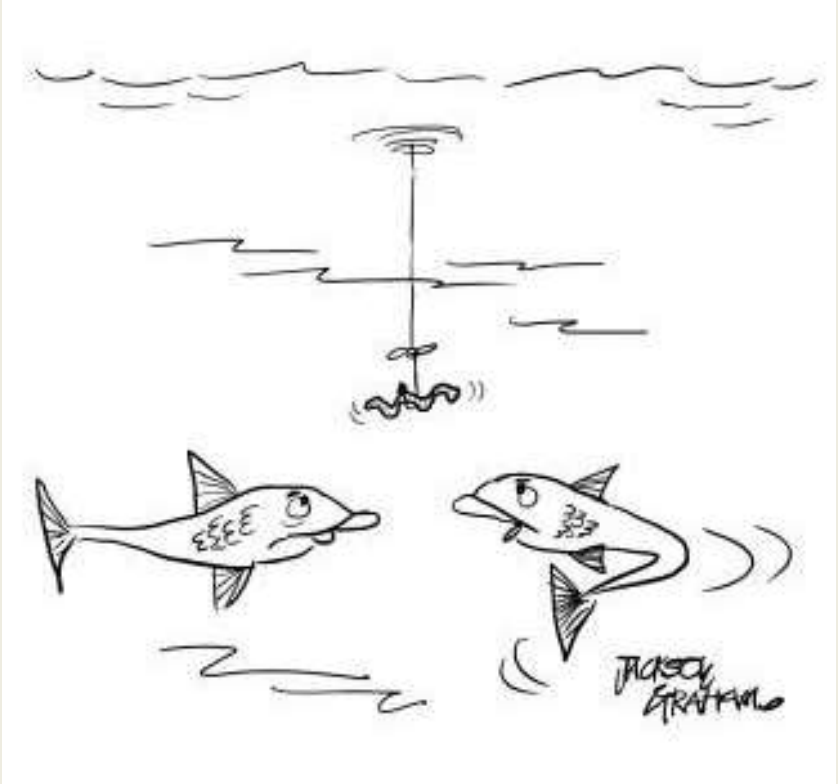
- Subject
  - "Person" from whom data is collected.
  - Often referred to as a "participant" or "source of data"
  - Subjects make up the *sample*

Sample

- Sample
  - The number of subjects data is collected from for an individual study
- Sample Examples:
  - **20** college freshmen
  - **13** individuals with a particular disease
  - The number of **fish in a lake caught in 1 hour**

Population

- Population
  - The entire group a researcher is interested in
- Population Examples:
  - **All** college freshmen
  - **Everyone** afflicted with a particular disease
  - **All** the fish in a lake



Random Sampling vs. Random Assignment

- Selecting participants (or cases) randomly from a population means that we can generalize from the sample to the population.
- This is a way to accurately describe a population, without measuring the whole universe.

- Random assignment is NOT the same as random sampling.
- The purpose of an experiment is to establish that a cause could occur (i.e., if it DOES occur in the experiment).
- It does not tell us anything about whether it occurs on everybody.
- It does imply the cause could occur for *anybody*.

Terms Part 3: Review

- **Subject:** Source of data. "Person" from whom data is collected.
- **Population:** The entire group a researcher is interested in.
- **Sample:** The number of subjects data is collected from for an individual study.
- **Group:** A number of subjects (greater than one) involved in an experiment.
  - **Within-Subject:** All subjects are exposed to the Independent Variable (IV).
  - **Between-Subject:** A between-subjects design makes comparisons between groups of subjects.

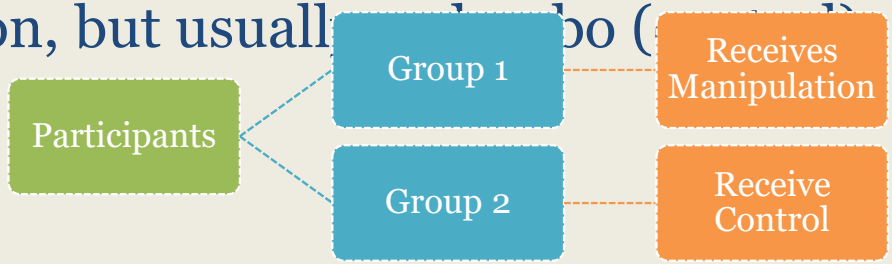
Experimental Design

- Which conditions will participants be in?
  - Between-Subjects Design: Different sets of participants are in different conditions.
  - Within-Subjects Design: Every participant is in every condition (but not all at once, and you must put them in random order)

http://www.condenaststore.com/-sp/There-s-a-flaw-in-your-experimental-design-All-the-mice-are-scorpios-Cartoon-Prints_i8641553_.htm

Between-Subjects Design

- Makes comparisons between groups of participants to determine the effect of the IV
- Different participants are used in each group; example
  - Experimental Group: Group that receives the manipulation (IV)
  - Control Group: Treated exactly the same as the experimental group, except they do not receive an experimental manipulation, but usuall[illegible]bo ([illegible])

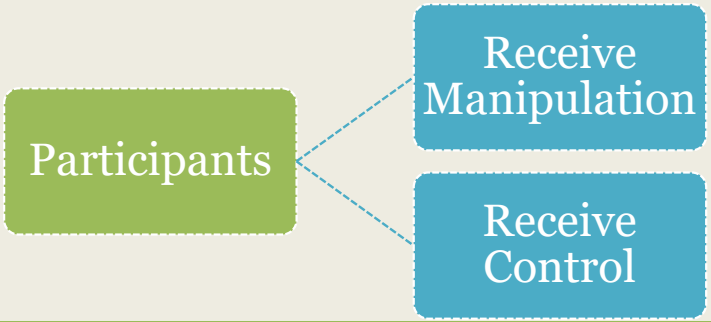


Between-Subjects Example

- Total population: 50
- Group 1
  - G1 Population: 25 rats
  - Treatment: Fed only cookies 3x day (experimental condition)
- Group 2
  - G2 Population: 25 rats
  - Treatment: Fed rat kibble 3x day (control)

Within-Subjects Design

- Subjects are exposed to all levels of the manipulation (IV)
- Only one group of participants, all of whom receive the same treatment(s) (incl. control)
- The participants' own performance is the basis of comparison
  - Their individual scores are compared for each condition



Within-Subjects Example

- How does exercise (yoga and jogging) affect memory?
  - 50 participants
  - All participants do 15 minutes of yoga before taking a memory test
  - Then, all participants do 15 minutes of jogging before taking a memory test
  - Now, we compare scores to determine which type of exercise had more effect on performance

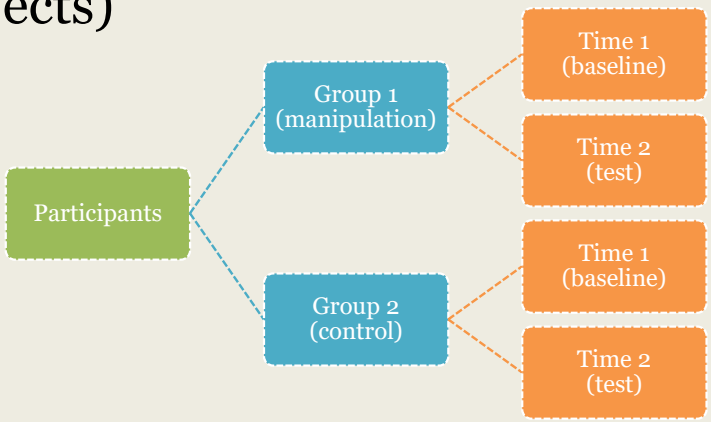
  - *What is confounded in this experiment???*

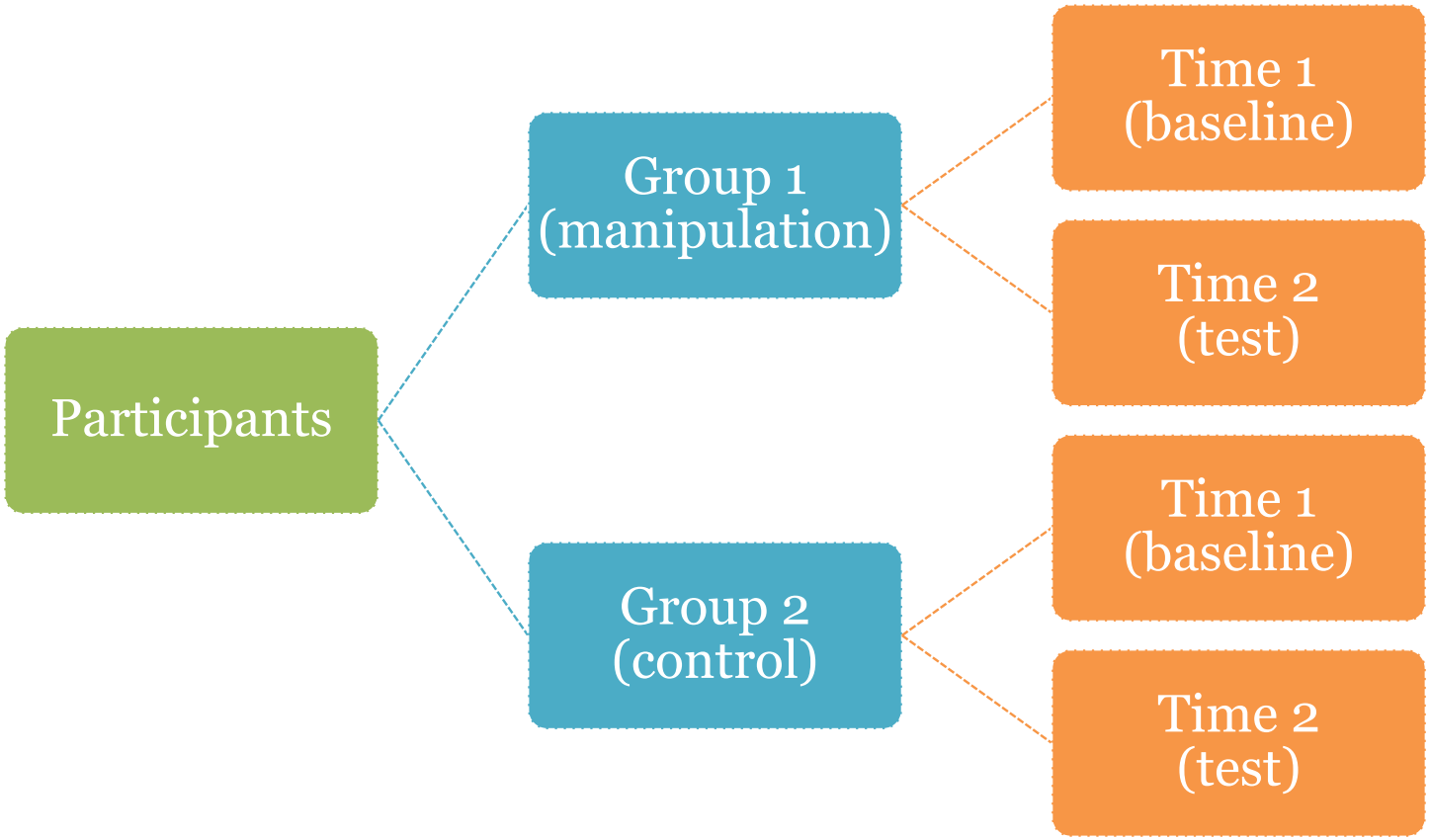
Within-Subjects Example: Repaired

- Since everybody FIRST did yoga, (test), THEN did jogging (test) we can only believe the results of the yoga-test part.
- But then, we have no comparison – no other condition– *USELESS!*
- We can't say that the results of the second test are due to jogging, because they are actually due to {yoga, followed by jogging, and practice on the test}.
- To avoid this problem, we would randomly assign Ps to do yoga OR jogging first, randomly assign different versions of the test to be first or second, and have a rest period between conditions.
- Randomizing the "nuisance" variables like test order, exercise type order, is called "counter-balancing."

Mixed Design

- Have characteristics of both Between- and Within-designs.
  - Suppose you want to see if there is an effect of the IV over time:
    - You could compare an experimental group and a control group (Between-Subjects)
    - You could also compare the performance of each subject over time (Within-Subjects)




Participants
Group 1 (manipulation)
Group 2 (control)
Time 1 (baseline)
Time 2 (test)
Time 1 (baseline)
Time 2 (test)