# Chapter 4: Experiments

# ■ **Observational Study versus Experiment**

**Definition:**

An **observational study** observes individuals and measures variables of interest but does not attempt to influence the responses.

An **experiment** deliberately imposes some treatment on individuals to measure their responses.  The individuals are randomly assigned to different treatment groups.

When our goal is to understand cause and effect, experiments are the *only* source of fully convincing data.

# ■ **Observational Study versus Experiment**

Observational studies of the effect of one variable on another often fail because of **confounding variables.**

> **Definition:**
>
> A **confounding variable** is a variable that is not among the explanatory or response variables in a study but that may influence the response variable.
>
> IE: So if in the next 6 months, we have people take vitamin c and the average number of colds go down.  Does this mean vitamin c causes cold to lessen?

Well-designed experiments take steps to avoid confounding.

# ■ **The Language of Experiments**

**Definition:**
An experiment is a statistical study in which we actually do something (a **treatment**) to people, animals, or objects (the **experimental units**) to observe the **response**.

# How to Experiment



A large high school track team decides this year to do strength training in the gym as well as training on the track. At the end of the season, the team has improved their times on average 10%, normally, they only improve 6%. Is this evidence that strength training works?

# How to Experiment Well: The Randomized Comparative Experiment

- Comparison alone isn't enough, if the treatments are given to groups that differ greatly, *bias* will result.  The solution to the problem of bias is **random assignment.**
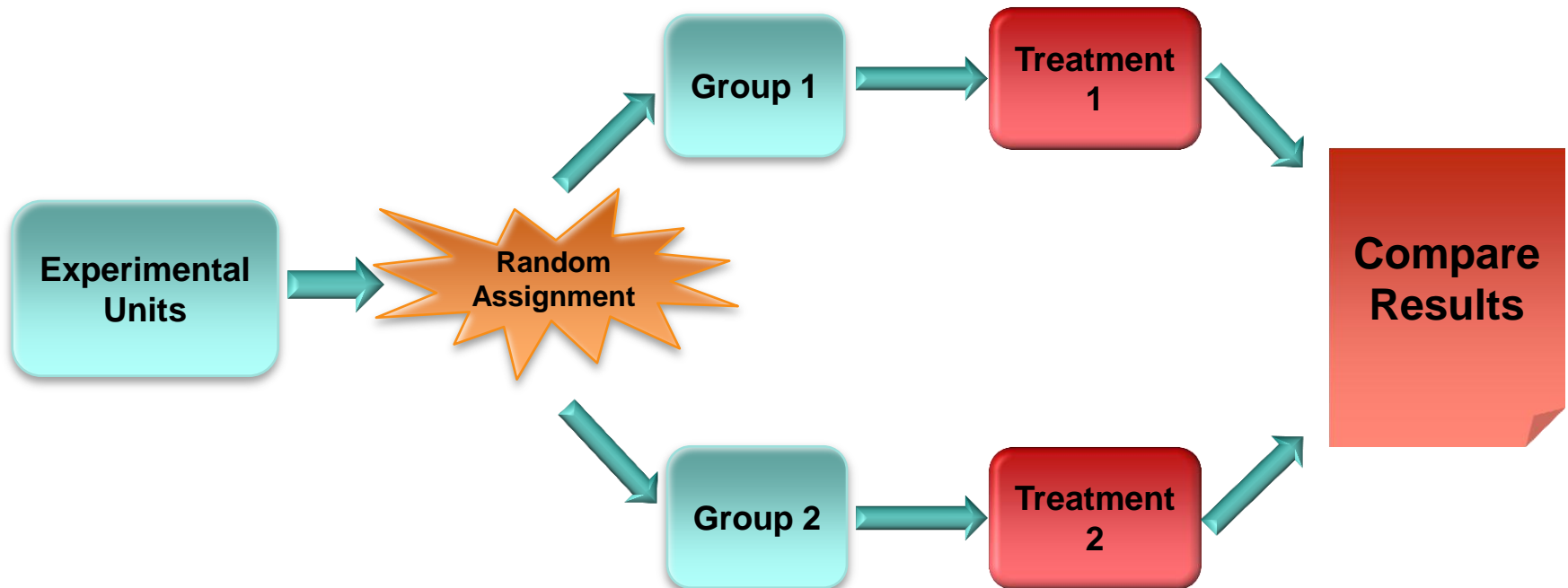
**<u>Definition:</u>**

In an experiment, **random assignment** means that experimental units are assigned to treatments at random, that is, using some sort of chance process.

# The Randomized Comparative Experiment

**Definition:**

In a **completely randomized design**, the treatments are assigned to all the experimental units completely by chance.

Some experiments may include a **control group** that receives an inactive treatment or an existing baseline treatment.

# Inference for Experiments

**Definition:**

An observed effect so large that it would rarely occur by chance is called **statistically significant**.

*A statistically significant association in data from a well-designed experiment does imply causation.*

# ■ Blocking

**Definition**

If a group of experimental units are known before the experiment to be similar in some way that is expected to affect the response to the treatments (like athletes in our pulse activity), we might stratify or group (called block), so that our treatment groups are more similar and we can see the effect of the treatment.
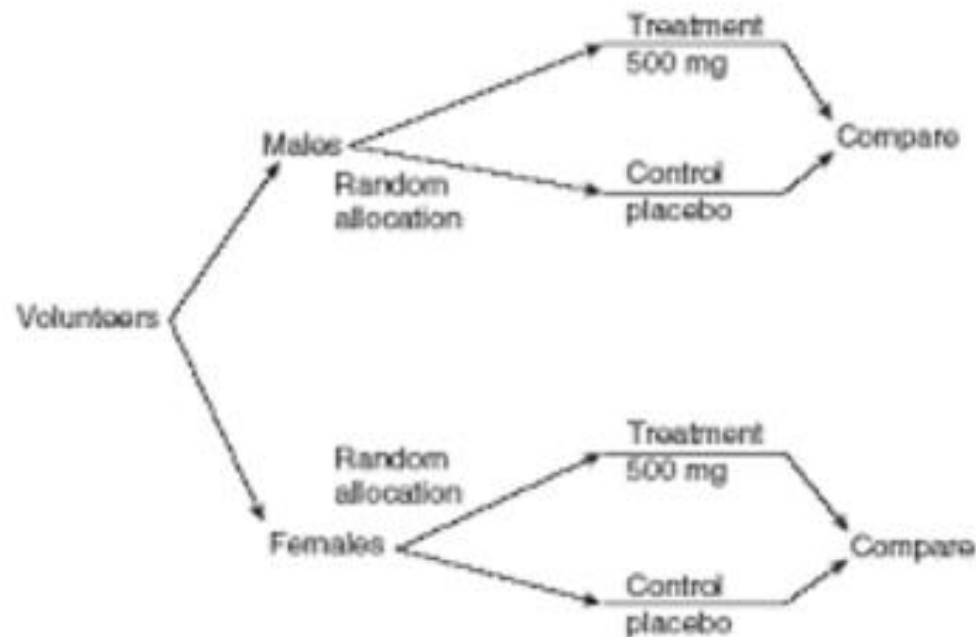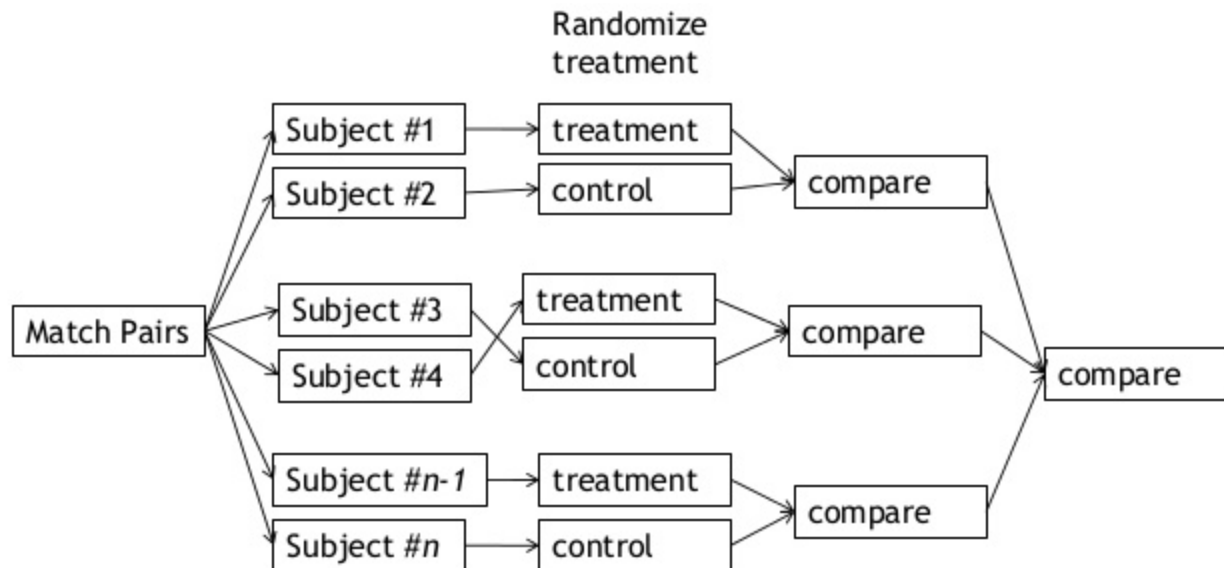
# ■ Matched-Pairs Design

**Definition**

A **matched-pairs design** is an experiment where blocks consist of matching pair of similar experimental units (could even be same subject).  Like in the hand accuracy activity, having everyone do both hands but randomize which one first.

Randomize treatment

Match Pairs → Subject #1 → treatment, Subject #2 → control → compare

Subject #3 → treatment, Subject #4 → control → compare

Subject #n-1 → treatment, Subject #n → control → compare

compare → compare → compare

# Design an Experiments

**Create an experiment to test if caffeine causes people to have better memory ability.**
Hypothesis:

What is the explanatory variable?
What is the response variable?

How are you going to do the experiment?
Can it be blind/double blind?

## ■ Design an Experiments

**You work for a tire company. They created a new tire called Hercules. They want to see if the tread lasts longer in the real world than their other tire – Jupiter. Create an experiment to test if Hercules last longer than Jupiter.**

Hypothesis:

What is the explanatory variable?
What is the response variable?

How are you going to do the experiment?
Can it be blind/double blind?