## Chapter 13 Notes
## Experiments

In **observational studies**, researchers simply observe what happens.

There are two types of observational studies:

1. **Retrospective Study**

2. **Prospective Study**



Example:
Researchers obtained a sample of 200 men and women and recorded their blood pressures, and then had them perform tasks relating to their memory and reaction time. The researchers found those with moderately high blood pressure (averaging 164/89 mm Hg) did worse on tests of memory and reaction time than those with normal blood pressure. (*Hypertension* 36[200]: 1079).

**Is this a prospective or retrospective observational study?**

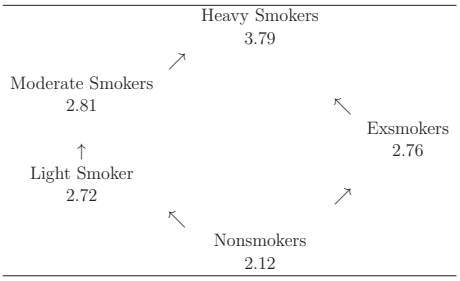


Example:
Researchers examined medical records of more than 360,000 Swedish men and found that those who were overweight or had high blood pressure had a higher risk of kidney cancer. (*New England Journal of Medicine* 3434[2000]: 1305.)

**Is this a prospective or retrospective observational study?**



Smoking and coronary artery disease:
Doll and Hill (1966) studied the mortality from heart disease of British doctors with various smoking behaviors.



## How do we establish causation?

The results from an observational study only show association and **cannot prove causation.** To prove causation we must conduct an **experiment**.



## Experiment Vocabulary

- **Factor**
- **Levels**
- **Treatment**
- **Experimental Units**



## Quick Bread Volume Experiment

A simple Comparative experiment was conducted to study the effect of baking temperature on the volume of quick bread prepared from a package mix. Four oven temperatures — low, medium, high, and very high — were tested by randomly assigning each of the four levels of the temperature to five package mixes (20 total package mixes).

**Identify the factors, levels, treatments, and experimental units for this study.**



## Insomnia Experiment

Forty volunteers suffering from insomnia agreed to participate in a month-long test. Half were randomly assigned to a special no-desserts diets; the other continued desserts as usual. Half of the people in each of these groups were randomly assigned to an exercise program, while the others did not exercise. Those who ate no desserts and engaged in exercise showed the most improvement.

**Identify the factors, levels, treatments, and experimental units for this study.**

## Principles of Experimental Design

### Principle 1: Control

We **control** sources of variation other than the factors we are testing by making conditions as similar as possible for all treatment groups.

### Principle 2: Randomization

We **randomize** the assignment of treatments to experimental units and the orders of trials/runs.



### Principle 3: Replication

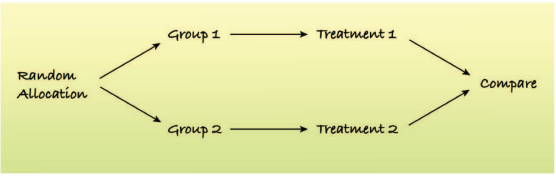
We **Replicate** within an experiment by assigning each treatment to multiple experimental units.

### Principle 4: Block (More Control)

We can group similar experimental units together into **blocks**.



### Experimental Diagram






### Microwave Popcorn Experiment

An experiment is to carried out to determine the optimal combination of microwave oven settings for microwave popcorn. Cooking time has three possible settings (3,4, and 5 minutes) and cooking power has two setting (low power, high power). The response is the number of unpopped kernels. 30 Bags of *Hyvee Extra Butter* microwave popcorn were used and 5 bags were randomly assigned to each treatment.

1. Identify the experimental Units

2. Identify the Factors in the Experiment.

3. Define Treatments in this experiment.

4. How is randomization incorporated in the experiment?

5. How is Replication incorporate in the experiment?

6. How could the investigators do to control for outside variables?



7. Suppose 5 microwaves were available to be used in the experiment. How could blocking be incorporated into this experiment.



Other Considerations

- **Control Group** – experimental units assigned to a baseline treatment
- **Placebo** – a null treatment known to have no effect
- **Placebo Effect** – tendency of many human subjects to show response even when administered a placebo
- **Blinding** – the researcher disguises the treatment
  - **Single Blind** – either the subject or the evaluator is unaware which treatment is being administered
  - **Double Blind** – both the subject *and* the evaluator are in the dark as to which treatment is being administered.



**Confounding** - when levels of one factor are associated with levels the levels of another factor.

**Statistical Significance**
How large do the differences need to be to say that there is a difference in the treatments?

## Vitamin C Experiment

A famous experiment on the effects of vitamin C on the prevention of cold in 868 children was conducted in 1976. 434 were randomly assigned to the *experimental group*. Children in this group received a 1,000-mg tablet of Vitamin C every day for the entire test period. The remaining children, who made up the *control group* received a placebo —an identical tablet containing no Vitamin C— also on a daily basis.

1. Identify the experimental Units.

2. Identify the Factor in the Experiment.

3. Define Treatments in this experiment.

4. How is randomization incorporated in the experiment?



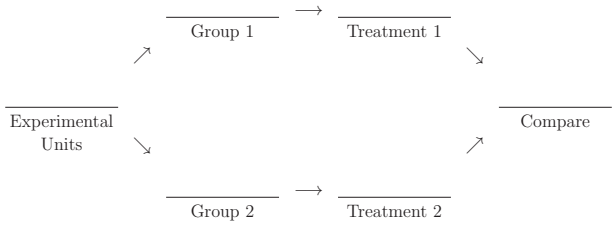
5. How is Replication incorporated into the experiment?

6. How could the investigators control for outside variables?

7. Suppose the children were chosen from two different elementary schools. For convenience the investigators chose to use the children at one school for the experimental group and the children at the other school for the control group. How might this **confound** the results?



## Vitamin C Experiment Diagrams




The results showed that the average number of colds per child was 0.38 for the Vitamin C group and 0.37 for the control group. The difference between the two groups (0.01 colds per child) was not statistically significant.