

**22S:30/105**  
**Statistical Methods and**  
**Computing**

**Designing Experiments**

Lecture 8  
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**Experiments**

- Recall: What is the critical difference between an *experiment* and an *observational study*?
- **experimental units**: individual items on which experiment is done
  - usually called **subjects** when they are human
  - we can measure a response variable individually on each experimental unit
- **treatment**: a specific experimental condition, controlled by the experimenter, and applied *to the units*

- example: agricultural field experiment
  - land available for use in the experiment is divided up into equal-sized “plots”; each plot is an experimental unit
  - same variety of corn planted in all plots
  - response variable for each plot is average number of bushels of corn harvested per acre
  - treatments are different types of fertilizers assigned to plots
- **factor**: a particular explanatory variable manipulated by the experimenter
  - a factor has one or more **levels** — different values that are assigned to different units
    - \* e.g., each type of fertilizer in the agricultural example is a different level of the factor “fertilizer type”

- A single experiment may involve more than one factor. In this case, each *treatment* is defined as the combination of levels of different factors.
  - example: more complex agricultural field experiment
    - \* factor A: fertilizer type with 3 levels
    - \* factor B: variety of corn, with 2 levels
    - \* then one of 6 possible treatments is assigned to each plot

## The importance of comparison in experiments

- **Comparative experiments** are used to separate the effects of an experimental treatment from those of extraneous variables.
- important when we can't control all extraneous variables

- Groups of subjects in a comparative experiment
  - **experimental group(s)** receive treatment(s) the effects of which are under study
  - **control group** receives no treatment or a sham treatment
- Example:
  - study reported in *Consumer Reports*, Feb. 1976
  - a group of senior citizens was randomly divided into 2 groups
    - \* group 1: daily doses of vitamin C
    - \* group 2: no treatment
  - At end of winter, vitamin C group reported fewer colds than no-treatment group. Investigator concluded that vitamin C helps to prevent colds.

- Example:
  - Autism is a severe emotional and developmental disorder that occurs in some children.
  - A medical case study reported that an autistic child who received a single injection of a hormone called secretin experience marked improvement in his autism.
  - We have no way of knowing what other variables might have influenced the child's autism.

## The placebo effect

- definition: A placebo is a dummy treatment
  - no direct (physical) effect on response variable
- In another study described in the same *Consumer Reports* article, two treatment groups
  - one group of subjects were given daily vitamin C and told it was a placebo
  - other group received a placebo and were told it was vitamin C
  - The group who *thought* they were receiving vitamin C reported fewer colds.

## An aside concerning medical studies

- Note: A study of the last-mentioned type would be considered unethical today.
  - “informed consent” required for participation in clinical trials
- For testing new treatments of diseases or conditions for which a treatment already exists, the best standard treatment is given to the control group.
  - It would be considered unethical to withhold an effective known treatment

## Randomization

- Another aspect of experimental design is how to determine which experimental units receive which treatment.
- randomization: assignment by chance
- **completely randomized design**: all experimental units are assigned at random among all the treatments

## Blinding in experiments with human subjects

- refers to preventing some people involved in the experiment from knowing which subjects are receiving which treatment
- single-blind experiment: subjects do not know which treatment they are receiving, but study personnel are not blinded
- double-blind experiment: neither the subjects nor any study personnel who administer treatment or evaluate response variable know which treatment subjects are receiving

## Example: the Lung Health Study

- clinical trial sponsored by the NIH involving 10 clinical centers in the US and Canada
- aim: to determine the effects on the decline of lung function in smokers already at risk for COPD (a lung disease) of:
  - a “stop smoking” program
  - daily use of an inhaled asthma drug
- response variable: change in FEV1 ( a measure of lung function ) from the time a subject entered the study until a follow-up visit 5 years later
- subjects: approximately 6000 smokers with mild impairment of lung function