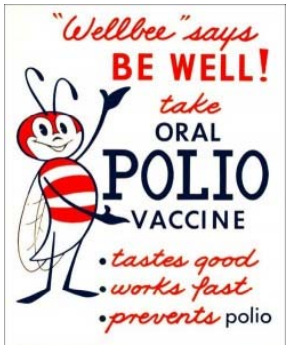


Chapter 13 – Experiments

Create Our Survey…

- Pick a topic
- Narrow last week's questions
  - Rework a question (or two) already there. Clean it up!
  - Decide multiple choice or fill-in-the-blank
  - If multiple choice, what are the choices?
  - If fill-in, what kind of input should I force the computer to check for? Text? Numbers? If numbers, is there a minimum/maximum?
  - Use Word or Notepad to write it up (I can show the class your computer)
- Be specific and try to reduce bias
- Be prepared to share your question(s) with the class for feedback

A Preview of Today…

- Surveys are used for estimating population parameters
  - What was the key to avoiding bias in surveys?
- Today we will discuss design tools for determining the effect of a treatment
  - Read the studies
    - *In One Study, a Heart Benefit for Chocolate* -- By Nicholas Bakalar http://www.nytimes.com/2009/09/15/health/15choc.html
    - *Shot beats nasal spray in adult seasonal flu vaccine trial* – By Robert Roos http://www.cidrap.umn.edu/cidrap/content/influenza/swineflu/news/sep2909flumist-jw.html
  - For each study,
    - What is the main question?
    - Who is the study about?
    - What are the variables?
  - Which study is more believable?

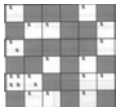
Proving Cause and Effect: The Experiment

- In an **observational study**, the subject chooses treatment
- An **experiment** requires random assignment of subjects to treatments.
  - The experimenter assigns treatment
  - There is at least one explanatory variable: **factor**
    - At least two **levels** of the factor are examined (treatment, no treatment)
    - **Experimental units** receive the treatment (or not)
  - There is at least one **response** variable.
- The Four Principles of Experimental Design
  - Control
    - Make conditions as similar as possible for all treatment groups
  - Randomize
    - Reduces bias due to uncontrolled sources of variation
    - "Control what you can, randomize the rest"
  - Replicate
    - Replication, Replication, Replication…
  - Block
    - Group similar items together

Father of the Four Principles

- R.A. Fisher proposed the four principles in
- *The Design of Experiments* (1935)
  - Revolutionized agriculture research
  - Provided methods to study several factors simultaneously

- Before Fisher
  - Fertilizer one year, not in another
    - Climate, seeds change over years
  - Fertilizer in one field, not in neighbor's
    - Different soil, drainage, water, etc
- After Fisher
  - Same field, same year. Apply fertilizer to randomly spaced spots.
    - Minimizes differences in weather, drainage, etc



The Ultimate Experiment: The Salk Polio Vaccine Trials of 1954

- Rejected studying non-consent children as control
  - Would bias against vaccine
  - More advantaged would consent
  - Less advantaged -> more natural immunity
  - Note: We can see this effect as some districts opted this route
- Rejected studying 1 or 2 grades, leaving other grades as control
- Rejected studying comparison of yearly rates
  - Polio spread by lack of hygiene/contagion
  - Much variation across years

Blinding and Blocking

- Children blind to treatment
  - Given a placebo – saline injections
- **Double blind experiment**:
  - Subject should not know if they receive the treatment
    - "Placebo effect" due to perception of treatment
    - Note: Some physicians think placebos are a good first choice for treatment of pain (sometimes works, cost nothing, no side effects)
  - People administering treatment and analyzing results should be blind to which subjects receive treatment
- **Blocking**: Try to make control group and treatment group as alike (except for treatment)

Data of Salk Polio Trials

- The Randomized, Controlled, Double-Blind Experiment

	n	Rate (per 100,000)
Treatment	200,000	28
Control	200,000	71
No Consent	350,000	46

- What do you notice about the rates of polio?
- Was the vaccine effective?

NFIP Study (Grade 2 Consent)

- Treatment: Grade 2 Consent

	n	Rate (per 100,000)
Grade 2 (Treatment)	225,000	25
Grade 1 and 3 (Control)	725,000	54
Grade 2 (No Consent)	125,000	44

- Are the results as clear as the Salk trials?
- Note the consent bias…
  - No consent Grade 2 (44) and No consent from the Salk trials (46) had lower rate of polio than Salk's consent control (71)…
  - Grade 1 and 3 had higher rate – included parents who would have consented

Do We Really Need a Randomly Assigned Control Group?

- Rejected studying non-consent children as control
  - Would bias against vaccine
  - Less advantaged would **NOT CONSENT**
    - Less advantaged -> more natural immunity
  - More advantaged would **CONSENT**
    - More educated
- Comparing Non-Treatment Groups
  - 71 > 46
  - 71 = more "advantaged"
  - 46 = more "less advantaged"

NIFP STUDY	n	Rate (per 100,000)
Grade 2 (Treatment)	225,000	25
Grade 1 and 3 (Control)	725,000	54
Grade 2 (No Consent)	125,000	44

THE 'GOOD' STUDY	n	Rate (per 100,000)
Treatment	200,000	28
Control	200,000	71
No Consent	350,000	46

Ethics of Experimentation

- The Salk Trials
  - All the kids waited to get doses of the drug in the Salk trials. Imagine being told the shots you got last spring were fake.
  - Some children who got the placebo shot died or were crippled by the disease when the vaccine might have saved them.
  - And if some doses of the vaccine were a little too "live", they may have actually caused the disease in children whose parents gave permission.
- Other issues
  - Is animal testing okay? For treatments that may save human lives? To learn if pet food is okay? To develop cosmetics?
  - If you were told you had months to live, would you volunteer for experiment? Would you prefer treatment or placebo group?
  - Is it ok to drill placebo holes in patients' skulls so they and their doctors won't know if they received an experimental implantation of nerve cells (possible treatment for Parkinson's… was approved)?
- "Informed consent"

Are the Treatments Really Different?

- So… 198 kids got polio.

	n	Rate (per 100,000)
Treatment	200,000	28
Control	200,000	71

- Maybe the 56 kids in the treatment group were destined to get polio…
- What's the chance that 198 random assignments to treatment and control would choose only 56 (or fewer) children for treatment?
  - Approximately 1 in a billion
- One of two things happened
  1. Either a 1 in a billion chance was just realized, or
  2. The vaccine was effective

Observation versus Experimentation

- Experiments allow us to deduce cause/effect. Observational studies do not.
- Observational studies—lurking variables
  - **Ex**: Smoking causes lung cancer
  - **Ex**: One can conclude (based on evidence) that the chance of getting lung cancer given that you recently quit smoking is MUCH higher than the chance of getting lung cancer given that you smoke (which is a little higher than the chance of getting lung cancer given that you haven't smoked for at least 5 years)… Why?
- Experiments fall subject to another pitfall… confounding
  - **Confounding** arises when the response is at least partially attributable to uncontrolled variables
    - **Ex**: Weather can affect a lot…

Project #2: Design and Analyze a Survey

- Groups of size 1-4
  - By the end of today, aim to be in a group. Either let Amy know your group members (even if it's just you), or submit yourself to random assignment.
- Design and Analyze a Survey
  - Pick a question of interest – a single question you have about people in general or about math 140 students in particular.
  - Using 3-5 questions, design a survey to administer to the class that will answer your proposed question.
  - Analysis
    - Using graphs and summary statistics, use the data you gather to answer your posed question
    - Also include a brief analysis of your survey tool. Did it behave as expected?
    - Final Write Up Max: 4 pages (typed, double spaced, including graphs)
- Two Due Dates (See Course Website)
  - Email your survey link OR bring 30 copies of your survey to class
  - Analysis

- If you are not strong with writing, be sure to visit the English tutors in the TLC lab…
  - Papers should include intro (and thesis statement), body, and conclusion

Project #2: Creating Your Survey

- How To Bring Your Survey To Class
  - Option 1: Online Survey
    - Create an account at http://www.surveymonkey.com/
    - Create your survey on that site
    - Email Amy the link to your survey by the deadline
  - Option 2: Paper Survey
    - Print up 30 copies of your survey
    - Note: You can use Survey Monkey (and then print/copy)
- More on Survey Monkey
  - Create the free account
  - Unless you're confident in analysis, limit your questions to "Multiple Choice" or "Single Textbox"
  - Analyzing Results
    - With the free account, you can't download results… You will have to click on "Analyze Results", "Browse Responses", then manually enter question responses in columns in Minitab.
    - Because this can be complicated, you may want to have at least one group member stay after class work to enter results during class time.

Class Work

- To get credit, it is your responsibility to get checked off.
  1. Chapter 13 Handout
     - NO ANSWERS TO CHECK AGAINST TODAY…

Homework

- Textbook/Routine Homework
  - Due Next Week (25% chance of collection)
  1. Read Chapter 13
  2. Pg 350-355: #1, 5, 7, 9, 27, 29, 31, 39, 43, 47
- Project/Exploration Homework
  - Project #2 Survey
  - Project #2 Analysis