Lecture 5/Chapter 5
Experiments

- Variables' Roles
- Outside Variables
- Single- or Double-Blind Experiments
- Flaws and Remedies in Experiments

Roles of variables

Most statistical studies of relationships attempt to establish evidence of **causation:** changes in values of one variable actually *cause* changes in values of the the other.

- **Explanatory variable:** the variable that is thought to explain or cause changes in the other variable in a relationship
- **Response variable:** the variable that is thought to be impacted by another variable in a relationship

In some disciplines, they're called *independent* & *dependent* vars.

Example: *Roles in Sugar/Activity Study*

- **Background**: Researchers seek to determine if sugar can cause hyperactivity in children.
- **Question:** What are the explanatory and response variables?
- **Response:** _____ is explanatory, _____ is response

Example: *Roles in Oatmeal Study*

- **Background**: *"Town Confirms Oatmeal Can Help Lower Cholesterol"*
- **Question:** What are the explanatory and response variables?
- **Response:** _____ is explanatory, _____ is response.

Outside variables

- **Confounding variable:** one that clouds the issue of causation because its values are tied in with those of the so-called explanatory variable, and also play a role in the so-called response variable's values
- **Interacting variable:** one whose presence or absence enables or disables explanatory variable's impact on response (like a trigger) or one that influences degree of causation

Confounding variables are much more common and problematic, especially in observational studies.

Example: *An Outside Variable*

- **Background**: Suppose sugar can cause hyperactivity in children only in cases where their general nutrition is extremely poor, but otherwise it has no effect.
- **Question:** What role does nutrition play in this scenario?
- **Response:**

Example: *Sugar → hyperactivity? (Review)*

- **Background**: To determine if sugar can cause hyperactivity in children, a researcher could conduct an **observational study.** Suppose it shows that ADHD is more likely to occur in children with high sugar intake.
- **Question:** What other explanations are possible, besides sugar causing hyperactivity?
- **Response:** Other factors can play a role:
  - _____
  - _____
  - _____
  - _____

These "other factors" are what we call **confounding variables.**

Example: *How to Avoid Confounding*

- **Background**: Researchers are concerned about confounding variables in the relationship between sugar and hyperactivity. **Question:** Should they perform an observational study or an experiment?
- **Response:**

Definitions

- **treatments**: values of explanatory variable imposed by researchers in an experiment
- **control group:** individuals for which the imposed explanatory value is at baseline or a neutral value, for comparison purposes

Random assignment to treatments (or to treatment vs. control) is the key to preventing confounding variables from entering into the relationship between explanatory & response

Example: *How to Avoid Confounding*

- **Background**: Researchers interested in the relationship between sugar and hyperactivity randomly assign half the children to consume low levels of sugar, the other half high levels.
- **Question:** Say boys tend to be hyper, and also tend to eat more sugar. How does random assignment prevent gender from entering in as a confounding variable?
- **Response:**

Definitions

- The **placebo effect** is when subjects respond to the *idea* of treatment, not the treatment itself.
- A **placebo** is a "dummy" treatment.
- A **blind** subject is unaware of which treatment he/she is receiving.
- The **experimenter effect** is biased assessment of (or attempt to influence) response due to knowledge of treatment assignment.
- A **blind** experimenter is unaware of which treatment a subject has received.

Example: *Double-blind Advantages*

- **Background**: Researchers are interested in the relationship between sugar and hyperactivity.
- **Question:** Why is a double-blind study best?
- **Response:**

Common Pitfalls in Experiments

- Confounding variables
- Interacting variables
- Placebo effect
- Hawthorne effect: people's performance can improve simply due to their awareness that they are being observed.
- Experimenter effect
- Lack of realism (lack of ecological validity)

Modifications to Complete Randomization

- **Block design:** First divide subjects into groups of individuals that are similar with respect to an important variable, then randomly assignment to treatments within each group.
- **Paired design:** Randomly assign 2 treatments (or treatment vs. control) within each pair of similar subjects.

Note: observational studies can also be paired.

Blocking in experiments is like stratification in sampling.

Example: *Assignment to Treatments*

- **Background**: In *Helping Stroke Victims,* German researchers who took steps to reduce the temperature of 25 people who had suffered severe strokes found that 14 survived instead of the expected 5.
- **Questions:** How did researchers determine which patients should get cooling treatment? Why is this important?
- **Response:**

Example: *Handling an Interacting Variable*

- **Background**: Grapefruit juice (interacting variable) inhibits the body's absorption of Prograf, an immuno-suppressant.
- **Questions:** How should researchers design a study of the effectiveness of Prograf?
- **Response:**

Example: *A Flawed Experiment*

- **Background**: To determine the effect of road salt on grass, a student plants grass in his basement in the winter and throws salt on half of the seedlings.
- **Question:** What's the flaw?
- **Response:**

Example: *A Flawed Experiment*

- **Background**: To determine the effect of "bad hair" on people's self-esteem, a researcher compares moods of subjects asked to think about bad hair days to those of subjects asked to think about some other negative situation.
- **Question:** What's the flaw?
- **Response:**

Example: *Another Flawed Experiment*

- **Background**: Suppose students are told they are part of an experiment to see if dimmer lights in the classroom during an exam can help them relax and do better.
- **Question:** If the students do unusually well, can we attribute this to having dimmer lights?
- **Response:**

Example: *An Unethical Experiment?*

- **Background**: A randomized-controlled double-blind study was conducted to see if special brain surgery could help patients with Parkinsons' disease.
- **Question:** What aspect of the study might be considered unethical?
- **Response:**

Example: *An Unethical Experiment?*

- **Background**: A randomized-controlled double-blind study was conducted to see if special brain surgery could help patients with Parkinsons' disease.
- **Question:** Why did the researchers feel compelled to include a control group?
- **Response:**

Example: *Single- or Double-Blind?*

- **Background**: A randomized-controlled study was conducted to see if special brain surgery could help patients with Parkinsons' disease.
- **Question:** Would it also be important for researchers to be blind in this experiment?
- **Response:**

Example: *Single- or Double-Blind?*

- **Background**: A study of a hair-growth cream measures density of scalp coverage before and after subjects use it for a certain number of weeks.
- **Question:** Would it be important for subjects to be blind in this experiment?
- **Response:**

Articles to be read before next lecture:

SIR RICHARD DOLL: A LIFE'S RESEARCH Fifty years ago, doctors at the UK's MRC published a scientific paper that was truly ground-breaking.They revealed that smoking can cause lung cancer. It was the first time the link had been confirmed.The findings were to change the minds and lives of millions of people around the world. In 1954, 80% of British adults smoked. Today, that figure is 26%. Sir Richard Doll was one of the men behind that pioneering study. "I personally thought it was tarring of the roads. We knew that there were carcinogens in tar." Sir Richard and his colleagues interviewed 700 lung cancer patients to try to identify a possible link."We asked them every question we could think of," he said." It wasn't long before it became clear that cigarette smoking may be to blame. I gave up smoking two-thirds of the way through that study."

(continued) The MRC researchers continued with their work. This time they enrolled every doctor in the UK in their study. In 1951, they asked 40,000 doctors if they smoked. Over the course of the next three years, they compared those answers with information about doctors who went on to develop lung cancer. They found a direct link.

Note: 1951 study was prospective (not retrospective case-control)

STUDY FINDS CELL PHONES RELATED TO ACCIDENTS

Drivers using cellular phones may be four times more likely to have auto accidents than people driving the old-fashioned way, talking to only their passengers or themselves, according to a new study…The researchers drew their conclusions from interviewing 699 drivers in Toronto who acknowledged being owners of cellular phones when they came to a Toronto police collision reporting center between June 1994 and August 1995. Their cellular phone bills were checked for whether they were using the phones either at or just before the time their accidents occurred. The researchers said there was no evidence of a cause-and-effect link between use of the phones and collisions, but a numerical risk making the chances more likely on the days they used the phones than on days they didn't. "For example, emotional stress may lead to both increased use of a cellular telephone and decreased driving ability. If so, individual calls may do nothing to alter the chances of a collision," the study said.

STUDY: CELL PHONE USE UPS ACCIDENT RISK Talking on a cell phone makes you drive like a retiree - even if you're only a teen, a new study shows.A report from the University of Utah says…they found that when 18-to-25-year-olds were placed in a driving simulator and talked on a cellular phone, they reacted to brake lights from a car in front of them as slowly as 65- to 74-year-olds who were not using a cell phone. In the simulator, each participant drove four 10-mile freeway trips lasting about 10 minutes each, talking on a cell phone with a research assistant during half the trip and driving without talking the other half. Only handsfree phones - considered safer - were used.The study found that drivers who talked on cell phones were 18 percent slower in braking and took 17 percent longer to regain the speed they lost when they braked…

ASBESTOS & LUNG CANCER? M.S. Kanarek and associates studied the relationship between cancer rates and levels of asbestos in the drinking water, in 722 Census tracts around San Francisco Bay. After adjusting for age and various demographic variables, but not smoking, they found a "strong relationship" between the rate of lung cancer among white males and the concentration of asbestos fibers in the drinking water: P-value < 0.001. Multiplying the concentration of asbestos by a factor of 100 was associated with an increase in the level of lung cancer by a factor of about 1.05, on average (meaning 21 out of 20,000 would have lung cancer instead of the expected 20). The investigators tested over 200 relationships---different types of cancer, different demographic groups, different ways of adjusting for possible confounding variables; the P-value for lung cancer in white males was by far the smallet one they got. Does asbestos in the drinking water cause lung cancer? Is the effect a strong one? [J. Utts]

THE FRESHMAN FIFTEEN" IS IT MYTH OR REALITY? Many students complain of weight gain of five to fifteen pounds or more during their first year at Cornell, but no scientific studies have looked at this until recently. Now, ongoing research at Cornell's Division of Nutritional Sciences has discovered that Cornell students tend to gain an average of four pounds during their first semester here.

HEART OF THE MATTER *Steven Tsui is head of the transplant team at Papworth Hospital (England). Last year, a third of patients with new hearts died within 30 days. What went wrong?*
Nationally, on average, approximately 10 per cent of patients undergoing heart transplants die within 30 days of their operation. At Papworth between January 2004 and December 2006, the 30-day mortality rate had been only 7 per cent. Between January and September 2007, the hospital had carried out 20 heart transplants, and seven patients ["a third"] had died within 30 days…
There are several reasons for the fall in usable hearts with which Tsui's team can work, but by far the greatest is the way we look after each other on the roads. The laws governing seatbelts, motorcycle helmets and speed, coupled with the tighter punishments for drink-driving and safer cars, have ensured that fewer young people kill themselves in accidents. Health and safety regulations have resulted in fewer fatal accidents at work.

(continued) And improvements in drugs in recent years for those who have suffered a brain haemorrhage or a stroke have also had a direct result on donor hearts. The drugs stimulate the brain to correct itself, but in the process thrashes the heart and lungs to deliver the extra blood pressure it needs. By the time a donor is normally declared brain dead, the heart has often been ruined too.When Papworth began its transplant programme, the average age of donors was about 27; but this has gone up gradually for the past 15 years, to the point where it is now 41; the outcome of transplantations has always been related to the age, health and strength of the donor heart.

M.S. Kanarek and associates studied the relationship between Cancer rates and levels of asbestos in the drinking water, in 722 Census tracts around San Francisco Bay. After adjusting for age and various demographic variables, but not smoking, they found a "strong relationship" between the rate of lung cancer among white males and the concentration of asbestos fibers in the drinking water: P < 1/1,000.
Multiplying the concentration of asbestos by a factor of 100 was Associated with an increase in the level of lung cancer by a factor of 1.05, on average. (If tract B has 100 times the concentration of asbestos fibers in the water as tract A, and the lung cancer rate for white males in tract A is 1 per 1,000 persons per year, a rate of 1.05 per 1,000 persons per year is predicted in tract B.)
The investigators tested over 200 relationships---different types of cancer, different demographic groups, different ways of adjusting for possible confounding variables; the P-value for lung cancer in white males was by far the smallest one they got.
Does asbestos in drinking water cause lung cancer? [Utts]