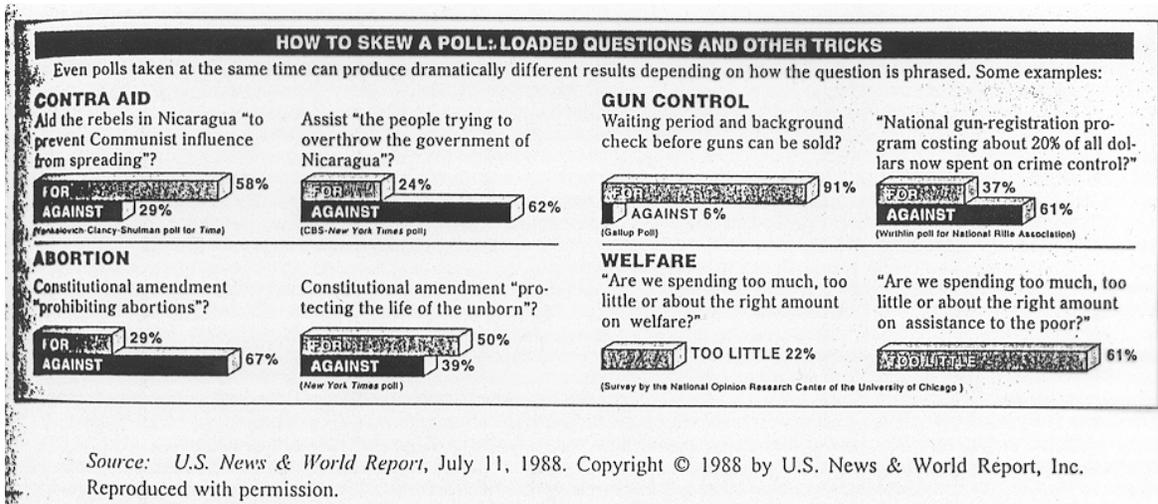


## 2. METHODS OF DATA COLLECTION

- Proper data collection is important.
- Even sophisticated statistical analyses can't compensate for data with bias, ambiguity or errors.



Some examples from Wainer, Palmer and Bradlow (Chance):

"In 90% of all deaths resulting from barroom brawls, the victim was the one who instigated the fight. One questions the wit of the remaining 10% who didn't point at the body on the floor when the police asked, 'Who started this?'"

"In testimony before a committee of the Hawaii State Senate, then considering a law requiring all motorcyclists to wear a helmet, one witness declared that despite having been in several accidents during his 20 years of motorcycle riding, a helmet would not have prevented any of the injuries he received. Who was unable to testify? Why?"

# Types of Data

**Quantitative Data** is measured on a numerical scale.

**Eg:** People's heights, salaries, and number of cars owned.

**Qualitative (categorical) data** is data which is classified into one of a group of categories. If the category has a numerical value, it is arbitrary.

**Eg:** Do you like statistics? Yes or No? Can use 0 for yes, 1 for no.

**Eg:** Democrat, Republican or undecided. Can use 0 for Democrat, 1 for Republican, 2 for undecided.

**Eg:** Business Horizons conducted a comprehensive survey of 800 CEOs who run the country's largest global corporations. Some of the variables measured are given below. Classify them as quantitative or qualitative.

(1) State of birth. (2) Age. (3) Educational Level. (4) Tenure with Firm (5) Total Compensation. (6) Area of Expertise. (7) Gender.

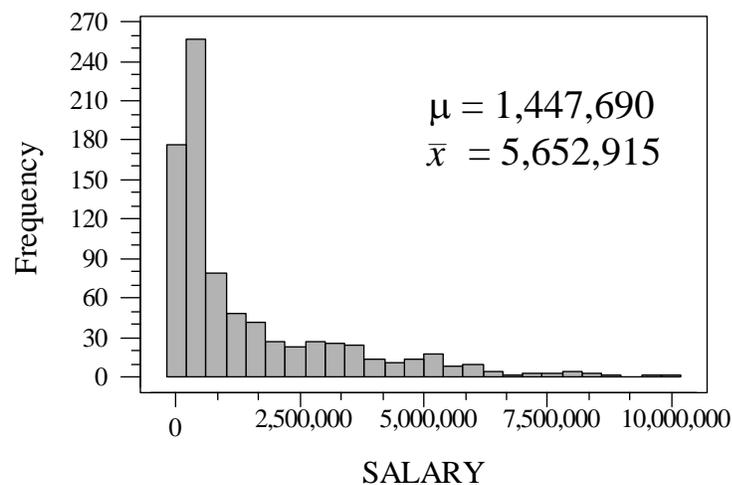
# Random Samples from a finite population

**Random Sample:** All elements of the population have the same chance of being chosen in the sample.

- Random sampling reduces bias in analysis.

**Eg:** In the baseball salaries data, we took a sample of the 100 top-earning players. This is clearly not random, and gives a very inflated picture of the average salary.

1998 Major League Baseball Salaries



- In a sample **with replacement**, an element of the population may be selected more than once.

**Eg:** Shuffle a deck of cards, pick one at random, put it back, repeat 20 times. The Ace of Spades may be selected several times.

- In a sample **without replacement**, an element can be selected at most once.

**Eg:** Shuffle cards, pick 20 cards at random. Ace of Spades can't appear more than once in the sample.

**Eg:** In the baseball salaries example, the sample was taken without replacement, since a player cannot appear in the sample more than once.

## Surveys

**Survey:** A set of questions about beliefs, attitudes, behaviors and other characteristics posed to individuals/organizations.

**Eg:** Telephone survey on approval of Obama as president.

Non-random sample: A radio talk show host asks for callers to phone in their opinions. Results could be extremely biased. (Why?)

Another non-random sample: We pick the first 250 names listed in alphabetical order. (Why isn't this random?)

Random sample with replacement: Computer dials phone numbers at random, using computer-simulated random numbers. Some phones may be dialed more than once.

(Is this method better than picking numbers at random from an alphabetized list?)

---

## **Types of Errors in Surveys**

**Coverage error:** If a complete list of elements of the population is not available, some elements will always be excluded from the sample.

**Eg:** Some people have unlisted numbers. Some people have no phone.

**Nonresponse Error:** People receive the survey but don't respond, due to sensitivity of questions ("Have you ever stolen anything?"), lack of time, etc. This can bias the results if the set of people who respond are not representative of the whole population.

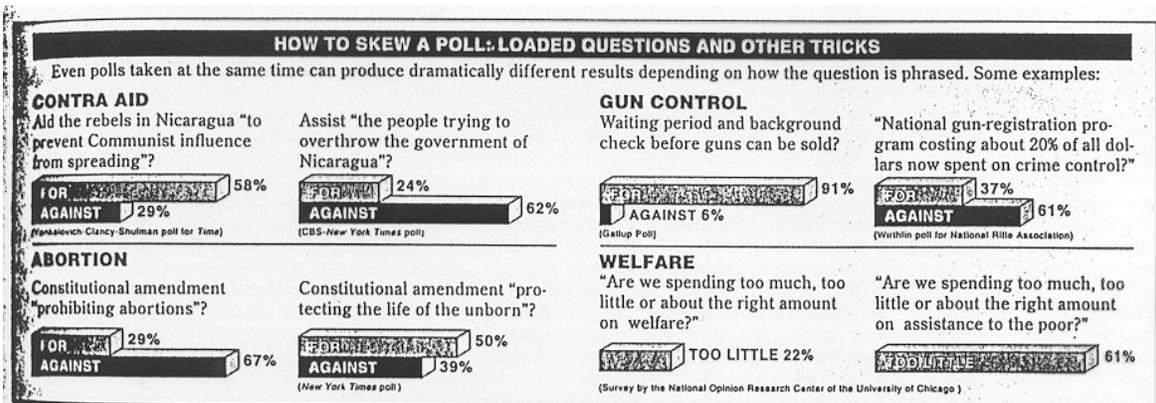
**Eg:** "Do you approve of the death penalty"? Those with the strongest opinions are the likeliest to respond. But these "vocal" people may have far different opinions from the others.

**Sampling Error:** caused by the sampling method itself.

**Eg:** Call first 250 names in an alphabetized list.

**Eg:** Clock the speed of the next 100 cars that pass a given point on a highway.

**Measurement Error:** Poor wording of survey questions or bad communication between interviewer and respondent. (Eg: ambiguous or leading questions).



# Experimental and Observational Studies

**Response Variable:** Variable of prime interest observed for each participant in the study.

**Treatment:** Something whose influence on the response variable is of interest.

At least one of the “treatments” is usually a “Control”, i.e., a non-treatment. An example for drug testing is a placebo (“sugar pill”), which has no pharmacological effect, but is not distinguishable in outward appearance from the actual drug.

If a control is not used, patients will often get better simply because they believe the treatment should work.

This is called the placebo effect, and is extremely powerful.

**Eg:** Does Viagra work? What about a sugar pill with a Viagra label? (Maybe just as effective!)

## **Placebos Prove So Powerful Even Experts Are Surprised**

by Sandra Blakeslee. *The New York Times*, 13 October 1998, D1.

A recent study of a baldness remedy found that 86% of the men taking the treatment either maintained or increased the amount of hair on their heads -- but so did 42% of the placebo group. Dr. Irving Kirsch, a University of Connecticut psychologist, reports that placebos are 55-60% as effective as medications like aspirin and codeine for treating pain.

THE NEW YORK TIMES, SUNDAY, APRIL 25, 1999

## Sham Surgery Returns As a Research Tool

The results of the first sham brain surgery study were reported last week in Toronto by a team of neurologists. Forty people with Parkinson's disease participated. Each had neurosurgery: four tiny holes, drilled through the forehead into the skull. But only half got the injections of fetal cells that might have repaired their damaged brains; the other half got nothing. One year later, three members of the placebo group said their symptoms had improved.

When you get it all...all it takes is FLONASE.



Ask your doctor about FLONASE —  
the multi-symptom nasal spray.  
Once a day relieves all your  
nasal allergy symptoms.

**Overall Adverse Experiences With >3% Incidence on Fluticasone Propionate  
in Controlled Clinical Trials With FLONASE Nasal Spray  
in Patients ≥4 Years With Seasonal or Perennial Allergic Rhinitis**

	Vehicle Placebo (n=758) %	FLONASE 100 mcg Once Daily (n=167) %	FLONASE 200 mcg Once Daily (n=782) %
Headache	14.6	6.6	16.1
Pharyngitis	7.2	6.0	7.8
Epistaxis	5.4	6.0	6.9
Nasal burning	2.6	2.4	3.2
Nausea/vomiting	2.0	4.8	2.6
Asthma symptoms	2.9	7.2	3.3
Cough	2.8	3.6	3.8

In an **experimental study**, the experimenter assigns treatments to participants. This is often done at random, and in a **double blind** fashion, so that neither the experimenter nor the participant knows which treatment was given.

In an **observational study**, the experimenter does not make the assignment of treatments to the participants. This makes it difficult to make cause-and-effect conclusions, since the effect of the treatment on the response may be **confounded** by other hidden factors.

Experimental studies are preferable.

**Eg: Clinical Trials.** Before a drug can be approved for use by the general public, the Food and Drug Administration requires a randomized clinical trial, to be funded by the pharmaceutical company. Ideally, these are multi-year, double blind studies, with careful attention paid to selection of the sample.

THE NEW YORK TIMES NATIONAL SUNDAY, MAY 16, 1999

## Fast-Growing System of Drug Testing Hides Conflicts for Doctors

### From Prospect to Prescription, How a Drug Comes to Market

From the initial spark of an idea to the approval for use by the public, the process of getting a new drug to the consumer takes an average of 12 to 20 years. Here is a look at how that process works:

#### Research and Development

Focuses on laboratory and animal testing.

##### DISCOVERY

Researchers work through thousands of compounds in an effort to find those with some impact on a disease.

##### PRE-CLINICAL TESTING

Hundreds of potential drugs are put through laboratory and animal tests to check the biological effect on the disease. Those found to have beneficial effects with reasonable safety are proposed for clinical study.

#### Clinical Trials

Human test subjects become involved at this stage.  = 100 patients

##### PHASE I

PATIENTS: 20-80



Volunteers are used to study the safe dosage range and how the drug is absorbed and metabolized by the body.

##### PHASE II

PATIENTS: 100-300



Volunteer patients, who have the disease, are used to test the drug's effectiveness and side effects.

##### PHASE III

PATIENTS: 1,000-5,000



The drug is studied in a larger, more diverse group of patients.

Results are analyzed, and if positive, a New Drug Application is submitted for approval.

#### F.D.A. Approval

The Food and Drug Administration reviews the application, assessing the quality of the research and whether the drugs are safe and effective.

#### Post-Market Trials

##### PHASE IV

PATIENTS: Number varies

Used to learn more about patients' reactions to the drug. Can be mandated by the F.D.A.

YEARS

2-10

4

F.D.A.

1

2

3

F.D.A.

1.5

YES

1+

Source: PHARMA, Tufts Center for the Study of Drug Development

The New York Times

**Eg:** It was difficult to prove that smoking causes lung cancer in humans since it is unethical (and impossible) to perform a controlled experiment on the long-term effects of smoking on humans. The available data are mostly observational.

An early (incorrect) theory on why throat cancer rates are higher in smokers than in non-smokers was proposed by R.A. Fisher, perhaps the greatest statistician who ever lived, and an avid pipe smoker. Fisher said that people who get throat cancer try pipe smoking to soothe the discomfort. In other words, throat cancer causes pipe smoking (!!).

From the observational data alone, it's hard to prove that Fisher has reversed the cause and the effect.