AP STATS Chapter 13 Observations and Experiments

Objective: To identify and distinguish between types of studies used to collect data.

There are two types of major studies

- Observational – When researchers observe individuals (subjects) and measure (record) variables of interest but do not influence the response. No manipulation of factors is involved.
- Experimental - When researchers deliberately impose some treatment on individuals (subjects) to measure (record) their responses.

Elements of a study

- Subjects – the term used when humans are used as participants in a study. (Ex – A study looks at the behaviors of graduating seniors)
- Experimental units – the term used when non-humans are used as part of a study. (Ex. A person study the migration habits of humming birds)
- Response variable – The outcome of the study, or outcomes.

Types of Observational Studies

- *Retrospective* -When subjects are selected and then their previous conditions or behaviors are determined. For example, in the church study, if researchers used people who have already died and determined whether or not they went to church.

Types of Observational Studies

- *Prospective* - When subjects are selected then followed to observe future outcomes. For example, in the church study, if researchers selected church goers and non-churches goers and then waited until they died.

Chocolate and happy babies. A University of Helsinki (Finland) study wanted to determine if chocolate consumption during pregnancy had an effect on infant temperament at age 6 months. Researchers began by asking 305 healthy pregnant women to report their chocolate consumption. Six months after birth, the researchers asked mother to rate their infants' temperament, including smiling, laughter, and fear. The babies born to women who had been eating chocolate daily during pregnancy were found to be more active and "positively reactive" – a measure that the investigators said encompasses traits like smiling and laughter.

What is the population?
What is the sample?
What is the parameter of interest?
What is the statistic?
What type of study do you think this was? Explain?
Who were the subjects?
What was the response variable?

The ADHD study is interesting and provides valuable information, however it has uncertainty and does not provide a "causal relationship." Without a causal relationship we cannot make claims about the study. (For example: smoking and/or drinking causes ADHD)

What can we do to make claims?

Set up an experiment.

Terms related to establishing an experiment

- Factor – The independent variable that is intentionally changed in the experiment
- Level – The different values/amounts of the independent variable.
- Treatment – The differ levels of a single factor or are made up of combinations of levels of two or more factors.
- Response Variable – The dependent variable that responds to the changes in the factor, it should be measurable.

Fuzzy Results in an Experiment

- Confounding variable – When two variables are associated in such a way that their effects on a response variable cannot be distinguished from each other.

ADHD Example

- Can an experiment be done to isolate smoking?
- What would the factor be?
- Could we have different levels?
- What is the response variable?
- How many treatments?

Cake Batter example

- A consumer group wants to test cake pans to see what works the best. (bakes evenly). It will use aluminum, glass and plastic pans in both electric and gas ovens.
- Experimental unit – cake batter
- Factors – type of pan and type of oven
- Levels – type of pan has 3 & type of oven has 2
- Response Variable – How evenly the cake bakes
- Treatments - 6

Experiments continued

- Suppose we wanted to design an experiment to see if caffeine affects pulse rate, in humans.
- Who will be the experimental units? *Humans (people)*
- What is the explanatory variable (factor)? *Caffeine*
- What is the response variable? *Pulse rate*

What do we need to decide to do an experiment?

- Ok now we need a plan, a starting point.
- Select the size of the sample
- Measure initial pulse rate
- Give each person some caffeine (We can use something like soda, Coke for example)
- Wait for a specified time (to let the caffeine enter the bloodstream)
- Measure the final pulse rate
- Compare final and initial rates
- Make a conclusion based on comparison

What are some problems with the plan?

- If there is a change in pulse rates, we don't know if caffeine was the cause. For example:
- Other factors that could affect the results:
- Wait time (what happens during this time and length of time)
- Body size
- Amount of soda
- Temperature
- Caffeine tolerance
- Food in stomach
- Recent caffeine intake

How do we eliminate some of the problems?

- Control Group - A group of subjects whose purpose is to provide a baseline for comparing the effects of the other treatments or between treatments.
- Placebo - A treatment known to have no effect, administered so that all groups experience the same conditions.

- Placebo effect - When subjects in an experiment know they are receiving a treatment and this knowing may cause a change in the response variable.

How to eliminate the Placebo effect?

- Blind -When a person doesn't know who is receiving which treatment.
- Treatment administrators

  Treatment evaluators
- Single Blind - When every one individual in one of these classes is blinded.
- Double Blind - When every individual in both classes in blinded.
- Lurking Variable - A variable that is not of interest in the current study but is thought to affect the response variable.

The Principles of Experimental Design

- (Direct) Control – The control is the standard against which the research compares the results from each treatment group (level) in the experiment. Meaning the group that receives no treatment or a placebo.
- Randomization – Subjects should be randomly assigned treatments to protect against bias.

The Principles of Experimental Design

- Replication – The repeated trials are the number of times the experiment is repeated to determine how the independent variable affected the results. One complete experiment is one repeated trial.
- Blocking – When groups of experimental units (Subjects or participants) are similar gather them into blocks to reduce variability so the differences caused by the treatment is clear.

Types of Experimental Design

- Completely Randomized – All experimental units have an equal chance of receiving any treatment.
- Blocked – With a randomized block design, the experimenter divides participants into subgroups called blocks based on similar attributes. Then, participants within each block are randomly assigned to a treatment.
- Matched pair – Subjects who are similar in ways not under study may be matched and then compared with each other on the variables of interest.

Statistically Significant

- When the observed difference is too large for us to believe that it is likely to have occurred naturally. If we decide they are too large, we'll attribute the differences to the treatments, and thus say the results are statistically significant.

Example: Men, Women and Advertising

- Women and men respond differently to advertising. Researchers would like to design an experiment to compare the effectiveness of three advertisements for the same product. 300 volunteer subjects, 180 men & 120 women, were used for this experiment.
- What are the experimental units (Subjects)?
- How many factors?, levels?, treatments?
- Is this blind? What is the response variable? Which design? Diagram?