AP Statistics
Unit 03 – Sampling & Study Design
Day 04 Notes – Blocking, Matched Pairs, and Double-Blind

Name: Key
Period: ______

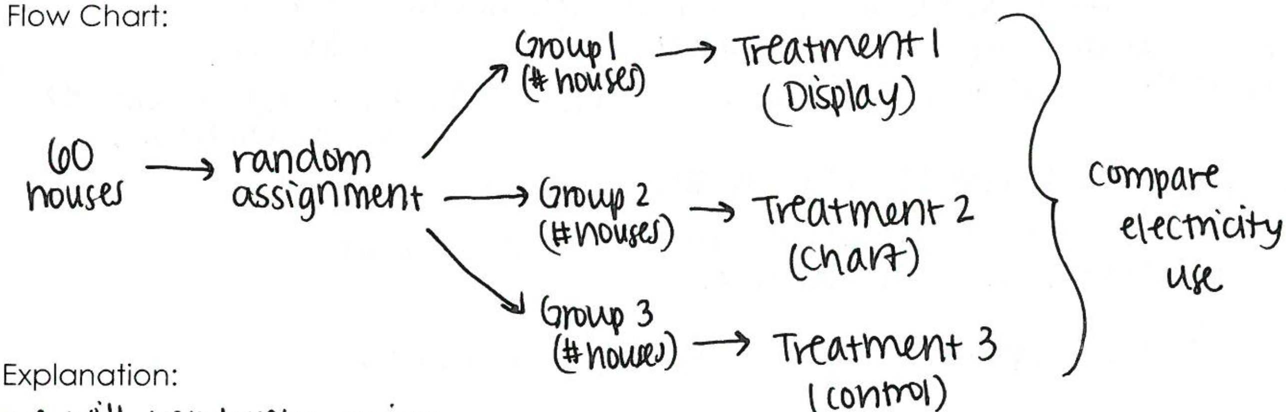
Review: Completely Randomized Design experimental units are assigned to the treatments completely by chance.

Example: Conserving Energy

Many utility companies have introduced programs to encourage energy conservation among their customers. An electric company considers placing small digital displays in households to show current electricity use and what the cost would be if this use continued for a month. Will the displays reduce electricity use? One cheaper approach is to give customers a chart and information about monitoring their electricity use from their outside meter. Would this method work almost as well? The company decided to conduct an experiment to compare these two approaches (display, chart) with a group of customers who receive information about energy consumption but no help in monitoring electricity use. (or nothing)

Describe a completely randomized design involving 60 single-family residences in the same city whose owners are willing to participate in such an experiment. ~~Where~~ write a few sentences explaining how you would implement your design. Include a picture (or flow chart) of your design. Then explain how the four principles of experimental design were implemented.

Flow Chart:



Explanation:

We will randomly assign the 60 houses to treatment groups. Each household will have a die rolled for it. If the die lands on a 1 or 2, the household will be assigned to treatment 1. If the die lands on a 3 or 4, the household will be assigned to treatment 2. If the die lands on a 5 or 6, the household will be assigned to treatment 3. We will do this until each household is assigned a treatment and there are at least 2 households per treatment group. We then let the homes use energy for a month, then we compare usage across the groups.

Principles of Experimental Design:

compare: we will compare a digital display, a chart display, and no monitoring on electricity use/energy consumption among 60 homes in the same city.

random assignment: completely randomized design (described above)

control: all homes are in the same city & they are all single-family residences. All owners willing to participate.

replication: there will be at least 2 homes/treatment.

Control Group: provides a baseline for comparing the effects of other treatments. the treatment for this group is usually no treatment or no change.

CHECK YOUR UNDERSTANDING

Music students often don't evaluate their own performances accurately. Can small-group discussions help? The subjects were 29 students preparing for the end-of-semester performance that is an important part of their grade. The 15 students in one group each videotaped a practice performance, evaluated it themselves, and then discussed the tape with a small group of other students. The remaining 14 students watched and evaluated their final performance ~~more accurately~~. individually. Accuracy of student evaluations were then compared between the groups.

1. Describe a completely randomized design for this experiment. Write a few sentences describing how you would implement your design. I want to compare the accuracy of self-evaluation of music performance between students who discussed their performance with a small group (T1) before evaluation and students who did not (T2). I will randomly assign students to treatment groups using a fair, 2-sided coin. Each student will flip a coin. If they flip heads, they will be assigned to treatment 1 (T1). If they flip tails, they will be assigned to treatment 2 (T2). Do this until all students are assigned a treatment. After they self-evaluate, compare the accuracy of evaluations between the 2 groups. control: all subjects are students prepping for end-of-semester music performances.
2. What is the purpose of the control group in this experiment? to have a baseline to compare the discussion group to, otherwise we won't have anything to measure improvement of accuracy.

Placebo Effect: the response to a dummy treatment.

Example: Curing Baldness and Soothing Pain

Want to help balding men keep their hair? Give them a placebo. One study found that 42% of balding men maintained or increased the amount of hair on their heads when they took a placebo. In another study, researchers zapped the wrists of 24 test subjects with a painful jolt of electricity. Then they rubbed a cream with no active medicine on the subjects' wrists and told them that the cream should help soothe the pain. When researchers shocked them again, 8 subjects said they experienced significantly less pain.

When the ailment is vague and psychological, like depression, some experts think that the placebo effect accounts for about three-quarters of the effect of the most widely used drug. Others disagree (argument for depression: actual chemical imbalance so a placebo won't help). In any case, "placebos work" is a good place to start when you think about planning medical experiments.

Cautions About Experimentation

- Need to treat all the experimental units identically in every way except for the treatments being compared

Double Blind: neither the subjects nor the experimenters/those who interact w/ the subjects and measure the response variable know which treatment a subject received. *do this whenever possible w/ human subjects!

- Helps limit response bias

Example: You are testing a new painkiller. You have 90 volunteers in which 30 try new meds, 30 are on old meds, and 30 are on a placebo. Volunteers don't know which ones they are taking nor do the doctors recording the patients report of pain level. This is so the doctors recording the results do not influence the volunteer responses or take biased notes. Also the volunteers don't imagine that they have less pain just because they know they have the new meds.

Single Blind: the individuals who are interacting with the subjects and measuring the response variable don't know which treatment is used but the subjects do. Or vice versa. *can be biased!

Lack of Realism: the subjects, treatments, or setting up of the experiment may not realistically duplicate the conditions we want to study.

- The most serious potential weakness of any experiment

Statistically Significant: An observed effect so large/unusual that it would rarely occur by chance alone.

Block Design

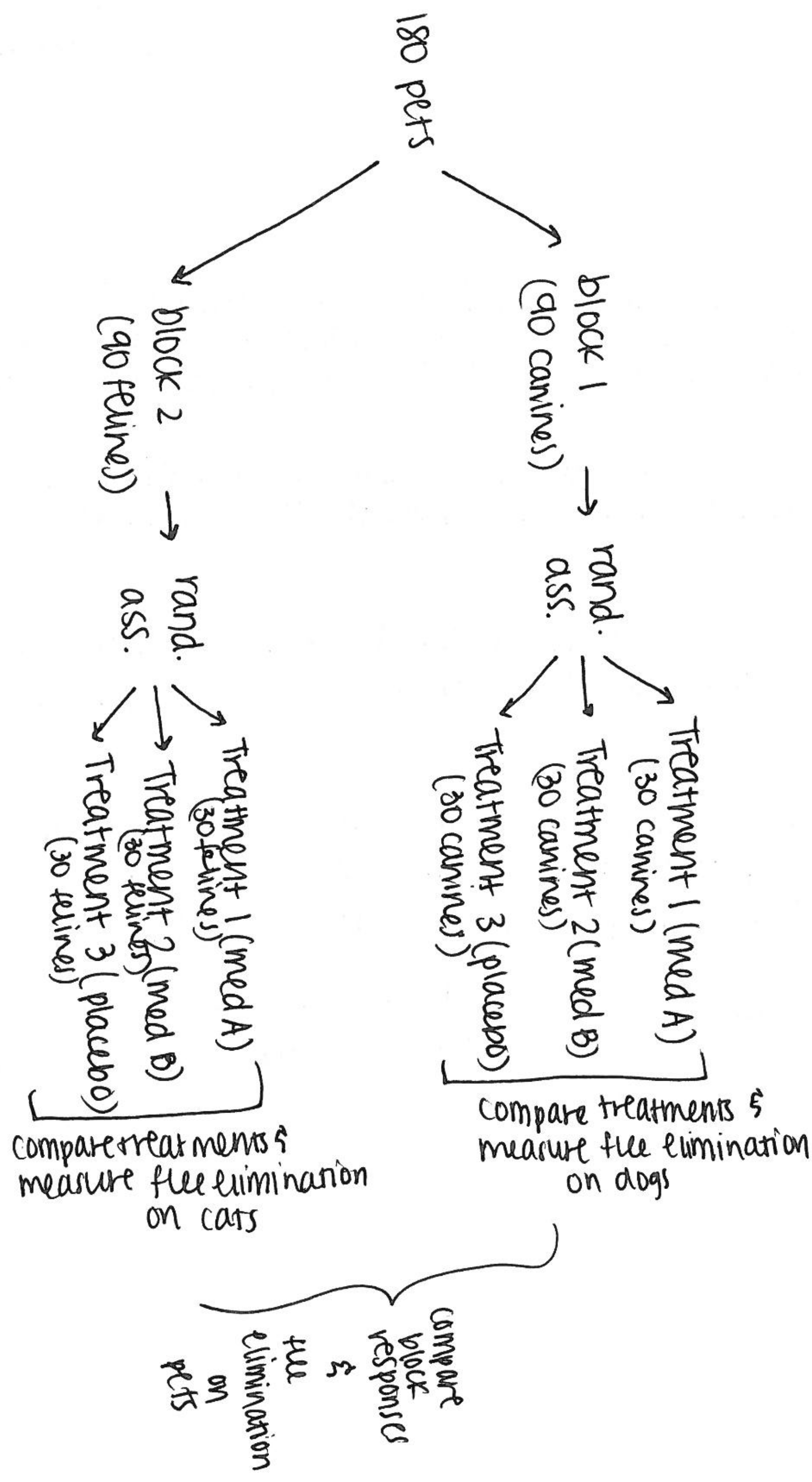
Block: a group of experimental units that are known before the experiment to be similar in some way that is expected to affect the response to the treatments.

Randomized Block Design: the random assignment of experimental units to treatments is carried out within the blocks.

- Allows us to draw separate conclusions about each block
- Allows us to do the same experiment to different blocks at the same time
- More precise overall conclusions because systematic difference can be removed when we study the overall effects
- Allows us to eliminate some hidden variables before the experiment begins

Example:

We want to determine if medication helps eliminate fleas on animals. We are given three treatments (med A, med B, placebo) and 180 pets (90 canines and 90 felines). How would we create this experiment to limit the number of lurking variables that might affect our outcome?



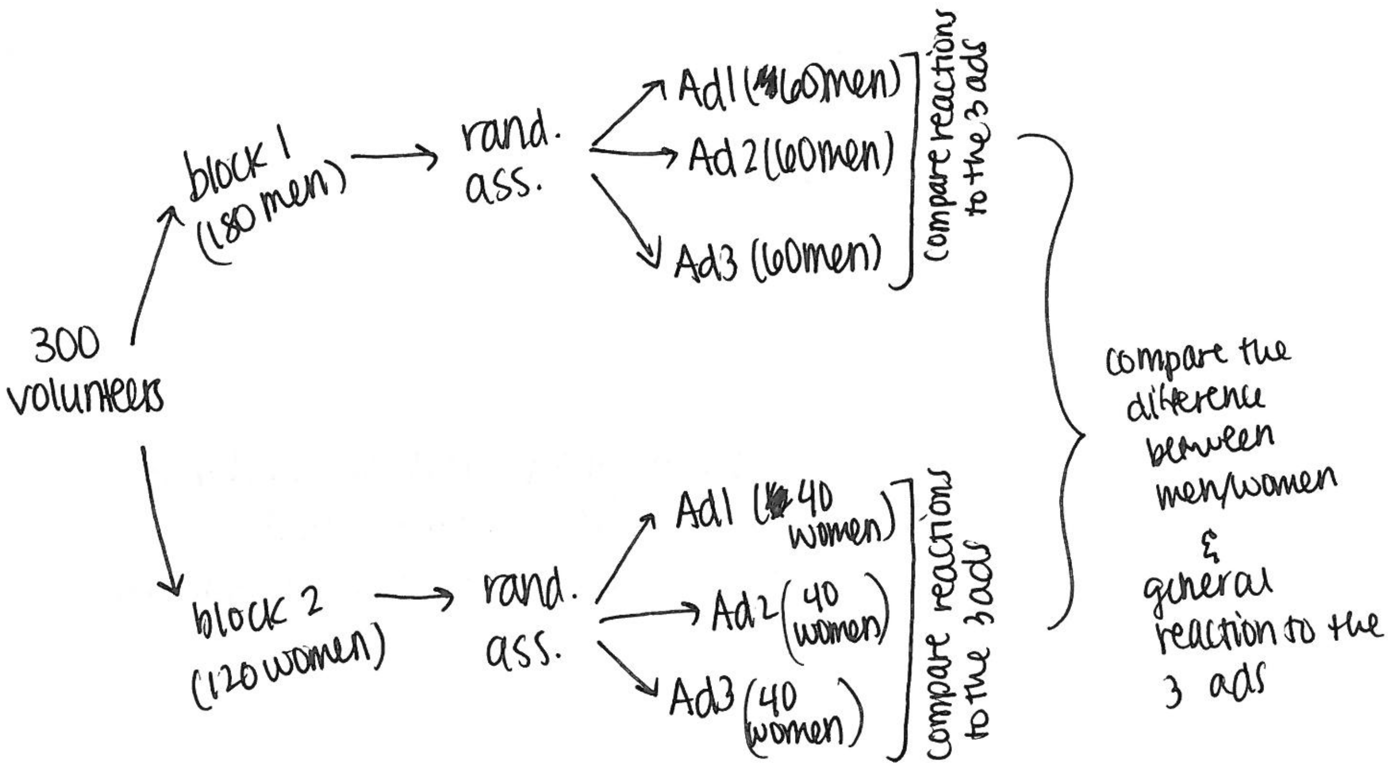
Example:

Women and men respond differently to advertising. Researchers would like to design and experiment to compare the effectiveness of their advertisements for the same product. 3 ads

a) Explain why a randomized block design might be preferable to a completely randomized design for this experiment.

men and women may respond differently to different types of ads. If we use CRD, we are looking at general responses w/o regard to gender (ignoring differency between men & women). block design will give more specific results and highlight the differences between the way men & women respond.

b) Outline a randomized block design using 300 volunteers (180 men and 120 women) as subjects. Describe how you would carry out the random assignment required by your design. (Hint: drawing a diagram will help your description of the randomized block design.)



I want to compare 3 chocolate ads and measure the response of 300 volunteers (How many would purchase this product?). I will block my subjects by gender because I think men & women may respond differently to each ad. Within each block, I will randomly assign subjects to a treatment group...

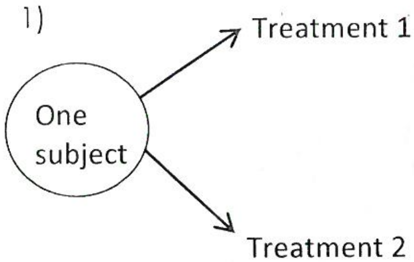
type of blocking:

Matched Pairs Design

Matched Pairs Design: a common form of blocking comparing just 2 treatments.

Two types of Matched Pair Designs

1)

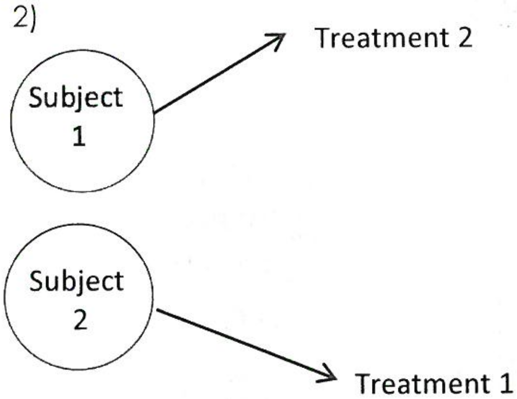


You could have as many subjects doing the same experiment. (sample size can be more than 1). The randomization comes in when you can randomly choose which subject gets which treatment first

one subject gets both treatments in random order or at the same time.

Example: We want to determine which type of rubber tires last the longest. You have 50 volunteers. For each volunteer they will use one of the treatments for 30 days and the other treatment for 30 days. You randomly choose which treatment will be used first for EACH subject.

2)



You can have as many pairs of subjects you want as long as the subjects' characteristics were all the same. The randomization comes in when you select which subject gets what treatment for EACH pair

Subjects are paired as similarly as possible (twins!) and each is given one treatment.

Example: You are comparing two different fertilizers and which one works best. You go to the forest and pick out 50 plots of land. You then pair those plots together based on similar characteristics (same sun, on a hill, etc.). Then you randomly choose for each pair, which plot will get treatment 1 and which will get treatment 2.

Example:

A psychologist wants to know if the difficulty of a task influences our estimate of how long we spend working at it. She designs two sets of mazes that subjects can work through on a computer. One set has easy mazes and the other has difficult mazes. Subjects work until told to stop (after 6 minutes, but subjects do not know this). They are then asked to estimate how long they worked. The psychologist has 30 students available to serve as subjects.

a) Describe an experiment using a completely randomized design to learn the effect of difficulty on estimated time.

Each student flips a fair, 2-sided coin. If they flip heads, they do the easy mazes. If they flip tails, they do the hard mazes. Then, compare the time estimates of the two groups.

b) Describe a randomized block design experimental design using the same 30 subjects.

block students by age. Younger kids may be worse at mazes, so separate (block) the students into elementary, middle, and high school students. within each block, use the CRD in part a to assign students to treatments. Then, compare time estimates within each block and also overall.

c) Describe a matched pairs experimental design using the same 30 subjects.

Each subject will do both sets of mazes in random order. Each subject will flip a coin to determine the order:
T1: heads: easy first, then hard.
T2: tails: hard first, then easy.

compare the time estimates given by the subjects for each treatment.

d) Which design would be more likely to detect a difference in the effects of the treatments?

Ⓒ Because both treatment groups have the exact same people in them! There is no group that just happens to be full of people who are good at time estimation (or some other variable that may affect the response).