Name Key 2017 Period

AP Statistics | Unit 03 – Sampling & Study Design Review

Multiple Choice

1. What is *bias* in conducting surveys?
   (a) An example of sampling error
   (b) Lack of a control group
E (c) Confouding variables
   (d) Difficulty in concluding cause and effect
   (e) A tendency to favor the selection of certain members of a population

2. Which of the following is ***incorrect?***
   ~~(a)~~ Blocking is to experiment design as stratification is to sampling design
   ~~(b)~~ By controlling certain variables, blocking can make conclusions more specific
D ~~(c)~~ The matched-pair design is a special case of blocking
   (d) Blocking results in increased accuracy because the blocks have smaller size than the original group (this makes the test more accurate)
   ~~(e)~~ In a randomized block design, the randomization occurs within the blocks

3. Consider the following studies being run by three different nursing home establishments.
   I. One nursing home has pets brought in for an hour every day to see if patient morale is improved
   II. One nursing home alllows hourly visits everyday by kindergarten children to see if patient morale is improved
   III. One nursing home administers antidepressants to all patients to see if patient morale is improved

   Which of the following is true?
E (a) None of these studies uses randomization
   (b) None of these studies uses control groups
   (c) None of these studies uses blinding
   (d) Important information can be obtained from all these studies, but none will be able to establish causal relationships
   (e) All of the above

4. Which of the following is ***not*** important in the design of experiments?
   ~~(a)~~ Control of confounding varibles
D ~~(b)~~ Randomization in assigning subjects to different treatments
   ~~(c)~~ Replication of the experiment using sufficient numbes of subjects
   (d) Observing without imposing change
   ~~(e)~~ Isolating variability due to differences between blocks

5. Some researchers believe that too much iron in the blood can raise the level of cholesterol. The iron level in the blood can be lowered by making periodic blood donations. A study is performed by randomly selecting half of a group of volunteers to give periodic blood donations while the rest do not. Is this an experiment or an observational study?
A (a) An experiment with a single factor
   (b) An experiment with control group and blinding
   (c) An experiment with blocking
   (d) An observational study with comparison and randomization
   (e) An obervational study with little if any bias

6. Which of the following is a true statement about the design of matched-pair experiments?
(a) Each subject may receive both treatments
A (b) Each pair of subjects receives the identical treatment, and differences in their responses are noted.
(c) Blocking is one form of matched-pair design
(d) Stratification into two equal sized strata is an example of matched pairs
(e) Randomization is unnecessary in true mathced pair designs

7. A town has one high school, which buses students from urban, suburban, and rural communities. Which of the following sampling techniques is most recommended in studying attitudes toward military enlistment after high school graduation?
(a) Cluster sample
(b) Simple random sample
C (c) Stratified sample
(d) Systematic sample
(e) Voluntary response sample

8. A large suburban school wants to assess student attitudes towards their mathematics textbook. The administration randomly selects 15 mathematics classes and gives the survey to every student in the class. This is an example of a
(a) Multistage sample
(b) Stratified sample
C (c) Cluster sample
(d) Simple random sample
(e) Convenience sample

9. A new cough medicine was given to a group of 25 students who had a cough due to the common cold. 30 minutes after taking the medicine, 20 students reported that their coughs had disappeared. From this information you conclude
(a) That the remedy is effective for the treatment of the coughs
C (b) Nothing, because the sample size is too small
(c) Nothing, because there is no control group for the comparison
(d) That the new treatment is better than the old medicine
(e) That the remedy is not effective for the treatment of coughs

10. 100 volunteers who suffer from anxiety take part in a study. 50 are selected at random and assigned to receive a new drug that is thought to be extremely effective in reducing anxiety. The other 50 are given an existing anti-anxiety drug. A doctor evaluates anxiety levels after two months of treatment to determine is there has been a larger reduction in the anxiety levels of those who take the new drug. This would be double blind if
B (a) Both drugs looked the same
(b) Neither the subject nor the doctor knew which treatment the subject had received
(c) The doctor couldn't see the subjects and the subjects couldn't see the doctor
(d) There was a third group that received the placebo
(e) All of the above

Free Response

11. A biologist is interested in studying the effect of growth-enhancing nutrients and different salinity (salt) levels in water on the growth of shrimp. The biologist has ordered a shipment of young tiger shrimp from a supply house for use in the study. The experiment is to be conducted in a laboratory where 20 tiger shrimp are placed randomly into each of 6 similar tanks in a controlled environment. The biologist is planning to use three different growth enhancing nutrients (A, B, and C) and two different salinity levels (low and high). 120 total shrimp

a) List the treatments that the biologist plans to use for the experiment.

6 total treatments, one per tank.

Salinity Level \ Growth-Enhancing Nutrient	A	B	C
low	T1	T2	T3
high	T4	T5	T6

Salinity nutrient
T1: low A
T2: low B
T3: low C
T4: high A
T5: high B
T6: high C

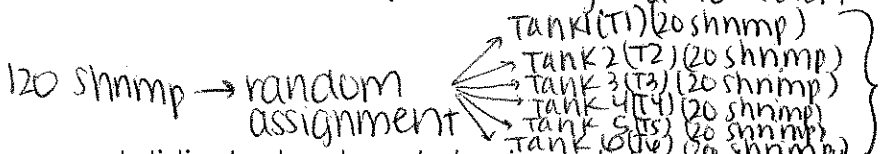
b) Using the treatments listed in part a, describe a completely randomized design that will allow the biologists to compare the shrimp's growth after 3 weeks. Include a diagram.

Compare: we will compare 3 different growth-enhancing nutrients and two salinity levels on the growth of shrimp.

Random Assignment: Label shrimp 1-120 by size (smallest to largest). Use 120 identical slips of paper, label each with a distinct number 1-120, place in a hat, and mix thoroughly. Pull out 20 slips of paper without replacement. The shrimp corresponding to the numbers on the slips pulled are assigned to treatment tank 1. Pull another 20 slips and assign the corresponding shrimp to treatment tank 2, then repeat for T3, T4, T5, and T6 so that all shrimp are assigned a treatment.

Control: Each shrimp is from the same supply house. All are tiger shrimp. Tanks are similar and all are in the same controlled environment.

Replication: 20 shrimp are assigned to each treatment.



c) Give one statistical advantage to having only tiger shrimp in the study. Explain why this is an advantage.

We are controlling the potentially confounding variable of shrimp type.

d) Give one statistical disadvantage to having only tiger shrimp in the study. Explain why this is a disadvantage.

We can only generalize our results to a population of Tiger shrimp.

12. A maker of fabric for clothing is setting up a new line to "finish" the raw fabric. The line will use either metal rollers or natural-bristle rollers to raise the surface of the fabric; a dyeing-cycle time of either 30 or 40 minutes; and a temperature of either 150 degrees or 175 degrees C. An experiment will compare all combinations of these choices. Three specimens of fabric will be subjected to each treatment and scored for quality.

Identify the following items (if possible). If you can't tell, then say so – this often happens when we read about a survey.

a) The population

fabric from this particular fabric maker
(likely specific type(s))

b) The sample (experimental units/subjects)

The 3 fabric specimens per treatment (24 total specimens)

c) The sampling method (indicate whether or not randomization was employed)

unknown (not stated).

d) The factors and response variable

roller type
dyeing cycle time
temperature

Quality score

e) The treatments or levels if applicable

roller type: metal vs. natural-bristle
dyeing cycle time: 30 vs. 40 minutes
temperature: 150°C vs. 175°C.

Treatments:

- metal roller < 30 min < 150°C — T1
- metal roller < 30 min < 175°C — T2
- metal roller < 40 min < 150°C — T3
- metal roller < 40 min < 175°C — T4
- natural roller < 30 min < 150°C — T5
- natural roller < 30 min < 175°C — T6
- natural roller < 40 min < 150°C — T7
- natural roller < 40 min < 175°C — T8

*tree instead of table for 3+ factors

f) Any potential sources of bias you can detect and any problems you see in generalizing to the population of interest

random assignment was not addressed, nor was random sampling. we also cannot generalize to all fabric types because we don't know what type was tested (cotton, spandex, etc.). we cannot generalize to any fabric by another maker.)

they may react differently to the treatments.

13. In search of a mosquito repellent that is safer than the ones that are currently on the market, scientists have developed a new compound that is rated as less toxic than the current compound, thus making a repellent that contains this new compound safer for human use. Scientists also believe that a repellent containing the new compound will be more effective than the ones that contain the current compound. To test the effectiveness of the new compound versus that of the current compound, scientists have randomly selected 100 people from a state.

Up to 100 bins, with an equal number of mosquitos in each bin, are available for use in the study. After a compound is applied to a participant's forearm, the participant will insert his or her forearm into a bin for 1 minute, and the number of mosquito bites on the arm at the end of that time will be determined.

a. Suppose the study is to be conducted using a completely randomized design. Completely describe the design and randomization process.

compare: we will compare an old repellant to a new mosquito repellant on # of mosquito bites on an arm after 1 minute.

random assignment: Have each of the 100 participants flip a fair, 2-sided coin. If they flip heads, they are assigned to the old repellant. If they flip tails, they are assigned to the new repellant. If either treatment ends up with 0 or 1 participants after all participants are assigned, have them all re-flip until there are at least 2 participants per treatment.

control: all participants are from the same state and have the same # of mosquitos in their bins.

replication: both treatments have at least 2 subjects.

100 participants → random assignment → Group 1 → T1 (old); Group 2 → T2 (new) } compare # of mosquito bites after 1 minute.

b. Suppose the study is to be conducted using a matched-pairs design. Completely describe the design and randomization process.

compare: we will compare an old repellant to a new mosquito repellant on # of mosquito bites on each arm.

random assignment: each participant will experience both repellants (one per arm). each participant flips a coin if they flip heads, they use the old repellant on their right arm and new on their left. if they flip tails, the repellants are switched (left = old, right = new). Both treatments will occur at the same time.

control: all subjects from the same state and have the same # of mosquitos in their bins.

replication: 100 subjects per treatment.

c. Which of the designs, the one in part (a) or the one in part (b), is better for testing the effectiveness of the new compound versus that of the current compound? Justify your answer.

the matched-pairs design is better because it allows for more subjects per treatment AND differences between people in each group (CRD) are eliminated (like being a mosquito magnet) because all subjects are now in both treatment groups.

14. Researchers who are studying a new shampoo formula plan to compare the condition of hair for people who use the new formula with the condition of hair for people who use the current formula. Twelve volunteers are available to participate in this study. Information on these volunteers (numbered 1 through 12) is shown in the table below.

a) youngest to oldest:

2, 1, 11, 10, 8, 9, 12, 3, 7, 4, 5, 6

Volunteer	Gender	Age
1	Male	21
2	Female	20
3	Male	47
4	Female	60
5	Female	62
6	Male	61
7	Male	58
8	Female	44
9	Male	44
10	Female	24
11	Male	23
12	Female	46

b) female youngest to oldest:

2, 10, 8, 12, 4, 5

male youngest to oldest:

1, 11, 9, 3, 7, 6

a) These researchers want to conduct an experiment involving the two formulas (new and current) of shampoo. They believe that the condition of hair changes with age but not gender. Because researchers want the size of the blocks in an experiment to be equal to the number of treatments, they will use blocks of size 2 in their experiment. Identify the volunteers (by number) that would be included in each of the six blocks and give the criteria you used to form the blocks. Blocks were created by ordering participants by age (younger to older) and grouping in sets of 2.

Block #	1	2	3	4	5	6
participants	2, 1	11, 10	8, 9	12, 3	7, 4	5, 6

b) Other researchers believe that hair condition differs with both age and gender. These researchers will also use blocks of size 2 in their experiment. Identify the volunteers (by number) that would be included in each of the six blocks and give the criteria you used to form the blocks. each block will be entirely male or female, grouped again by age (in pairs, youngest to oldest).

Block #	1	2	3	4	5	6
participants	2, 10	8, 12	4, 5	1, 11	9, 3	7, 6

c) The researchers in part (b) decide to select three of the six blocks to receive the new formula and to give the other three blocks the current formula. Is this an appropriate way to assign treatments? If so, describe a method for selecting the three blocks to receive the new formula. If not, describe an appropriate method for assigning treatments. No, because random assignment should occur within blocks. Otherwise, we could end up w/ all males in T1 and all females in T2. We want to see the treatments on all types of individuals (T1 and T2 on similar subjects). Randomly assign T1 to one subject per block and T2 to the other. Flip a fair, 2-sided coin for each block. Heads = older person gets T1, younger gets T2. Tails = younger gets T1, older gets T2.

15. A manufacturer of boots plans to conduct an experiment to compare a new method of waterproofing to the current method. The appearance of the boots is not changed by either method. The company recruits 100 volunteers in Seattle, where it rains frequently, to wear the boots as they normally would for 6 months. At the end of the 6 months, the boots will be returned to the company to be evaluated for water damage.

* you can choose CRD or block design if you want

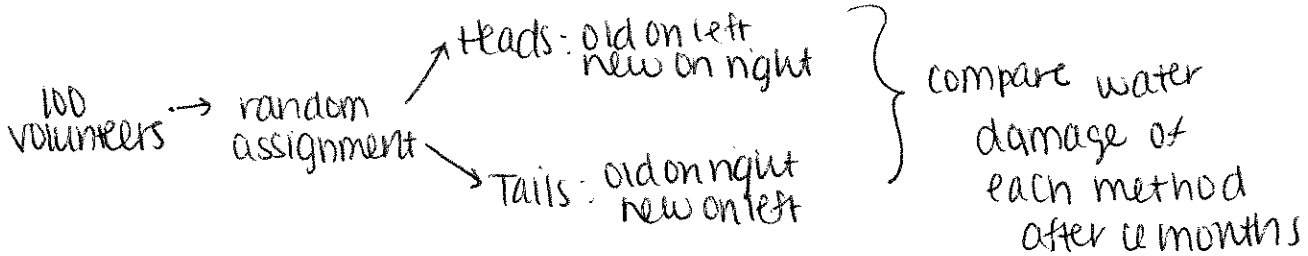
a) Describe a design for this experiment that uses the 100 volunteers. Include a few sentences on how it would be implemented. I will use a matched-pairs design.

Compare: we are comparing a new and old treatment of waterproofing boots on water damage.

Random Assignment: Each subject will receive both treatments. They will all wear one boot with the old waterproofing method and one with the new waterproofing method. Each subject will flip a fair, 2-sided coin. If they flip heads, their left boot will have the old treatment + right will have the new. If they flip tails, their right boot will have the old treatment and left will have the new.

Control: All subjects wear the boots for 6 months in the same city (Seattle). Because this is a matched pairs design, we are controlling confounding variables like amount of time spent walking outside in the rain.

Replication: Each treatment has 100 subjects/experimental units (boots).



b) Could your design be double blind? Explain.

Yes, if neither the experimenter (or boot-checker) or subjects knew who was getting which treatment/in which order.

16. High cholesterol level in people can be reduced by exercise or by drug treatment. A pharmaceutical company has developed a new cholesterol-reducing drug. Researchers would like to compare its effects to the effects of the cholesterol-reducing drug that is currently available on the market. Volunteers who have a history of high cholesterol and who are currently not on medication will be recruited to participate in a study.

*we could also include a placebo treatment.

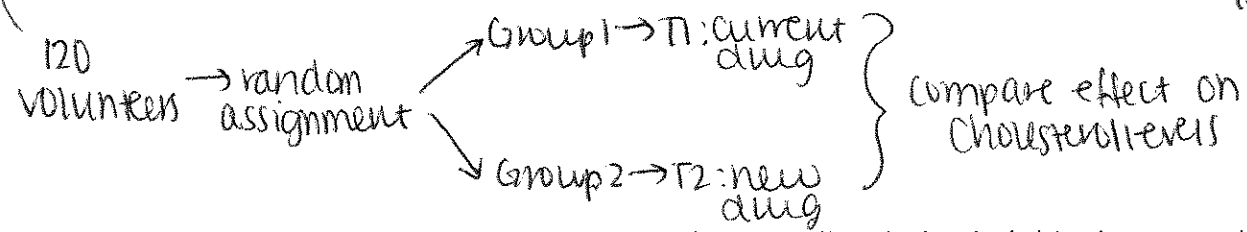
a) Explain how you would carry out a completely randomized experiment for the study.

Compare: we will compare the current cholesterol-reducing drug to a new drug on cholesterol levels.

Random Assignment: Each subject will flip a fair, 2-sided coin. If they flip heads, they will receive the current drug (T1) and if they flip tails, they will receive the new drug (T2).

Control: Every subject has a history of high cholesterol and is not currently taking any medication.

Replication: At least 2 subjects will be assigned to each treatment group. If only 1 or none are assigned to a treatment, the random assignment will be redone until this condition is met. (choose this #)



b) Describe an experimental design that would improve the design in (a) by incorporating blocking. *can also use more blocks or blocks on a different top (seventy of high cholesterol)

Compare: we will compare the current cholesterol-reducing drug to the new drug on cholesterol levels, among blocks of exercise frequency: 0-3 times/week vs. 4+ times/week.

random assignment: After