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Chapter 12 - Experiments and Observational Studies

Section 12.1

1. Steroids.

This is an observational study because the sports writer is not randomly

assigning players to take steroids or not take steroids; the writer is merely

observing home run totals between two eras. It would be unwise to conclude steroids caused any increases in home runs because we need to consider other factors besides steroids—factors possibly leading to more home runs include better equipment, players training more in the offseason, smaller ballparks, better scouting techniques, etc.

2. E-commerce.

This is an observational study because the student is not randomly assigning

companies to use or not use the Internet for business transactions. If profitability did increase in the 2000s, it could have been due to a number of factors, not   
specifically the Internet as a means for conducting business.

Section 12.2

3. Tips.

Each of the 40 deliveries is an experimental unit. He has randomized the experiment by flipping a coin to decide whether or not to phone.

4. Tomatoes.

Each tomato plant is an experimental unit. The tastiness and juiciness of the tomatoes will be the response variables.

5. Tips II.

The factor is calling, and the levels are whether or not he calls the customer. The response variable is the tip percentage for each delivery.

6. Tomatoes II.

The factor is the fertilizer, applied at three levels 0, half, and full dose. To measure tastiness and juiciness, we’ll need trained tasters.

Section 12.3

7. Tips again.

By calling some customers but not others during the same run, the driver has   
controlled many variables, such as day of the week, season, and weather. The   
experiment was randomized because he flipped a coin to determine whether or   
not to phone and it was replicated because he did this for 40 deliveries.

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8. Tomatoes again.

Tomato plants should be grown in the same field, near each other so differences in soil, sun, and rain can be controlled. The experiment is randomized because plants are assigned at random to treatment levels. It is replicated because 6   
plants are assigned to each level.

Section 12.4

9. More tips.

Because customers don’t know about the experiment, those that are called don’t know that others are not, and vice versa. Thus, the customers are blind. That would make this a single-blind study. It can’t be double-blind because the   
delivery driver must know whether or not he phones.

10. More tomatoes.

If the tomato taster is blind, then this is a single-blind study. To make it double-  
blind, everyone who cares for the tomato plants must be blind to their treatment.   
This might be done, for example, by treating all plants with solutions that look   
the same, but applying a “placebo” fertilizer to the plants assigned to receive   
none.

Section 12.5

11. Block that tip.

Yes. Driver is now a block. The experiment is randomized within each block.   
This is a good idea because some drivers might generally get higher tips than   
others, but the goal of the experiment is to study the effect of phone calls.   
Blocking on driver eliminates the variability in tips inherent to the driver.

12. Blocking tomatoes.

Yes. Garden centers are the blocks. It is important to randomize the assignment of plants to treatments within each block so that any differences between garden centers won’t affect the results.

Section 12.6

13. Confounded tips.

Answers may vary. The cost or size of a delivery may confound his results.   
Larger orders may generally tip a higher or lower percentage of the bill.

14. Tomatoes finis.

Answers may vary. Confounding factors could include variations in soil fertility,   
sunlight availability, or rainfall. Some plants might become infested with pests.

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Chapter Exercises

15. Standardized test scores.

a) No, this is not an experiment. There are no imposed treatments. This is a   
 retrospective observational study.

b) We cannot conclude that the differences in score are caused by differences in   
 parental income. There may be lurking variables that are associated with both   
 SAT score and parental income.

16. Heart attacks and height.

a) No, this is not an experiment. There are no imposed treatments. This is a   
 retrospective observational study.

b) We cannot conclude that shorter men are at higher risk of dying from a heart

attack. There may be lurking variables that are associated with both height and risk of heart attack.

17. MS and vitamin D.

a) This is a retrospective observational study.

b) This is an appropriate choice, since MS is a relatively rare disease.

c) The subjects were U.S. military personnel, some of whom had developed MS.

d) The variables were the vitamin D blood levels and whether or not the subject   
 developed MS.

18. Super Bowl commercials.

a) This is a stratified sample. The question was about population values, namely

the proportions of men and women who look forward to more commercials. No treatment was applied, so this is not an experiment.

b) Yes, the design was appropriate.

19. Menopause.

a) This was a randomized, comparative, placebo-controlled experiment.

b) Yes, such an experiment is the right way to determine whether black cohosh is an   
 effective treatment for hot flashes.

c) The subjects were 351 women, aged 45 to 55 who reported at least two hot   
 flashes a day.

d) The treatments were black cohosh, a multi-herb supplement, plus advice to   
 consume more soy foods, estrogen, and a placebo. The response was the   
 women’s self-reported symptoms, presumably the frequency of hot flashes.

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20. Honesty.

a) This is an experiment. The picture is the controlled factor. Randomization may   
 have been used to decide which days each picture appeared.

b) The treatment was the picture behind the coffee station. The response variable   
 was the average contribution.

c) The differences in money contributed were larger than could be reasonably   
 attributed to usual day-to-day variation.

21. a) This is an experiment, since treatments were imposed.

b) The subjects studied were 30 patients with bipolar disorder.

c) The experiment has 1 factor (omega-3 fats from fish oil), at 2 levels (high dose of   
 omega-3 fats from fish oil and no omega-3 fats from fish oil).

d) 1 factor, at 2 levels gives a total of 2 treatments.

e) The response variable is “improvement”, but there is no indication of how the   
 response variable was measured.

f) There is no information about the design of the experiment.

g) The experiment is blinded, since the use of a placebo keeps the patients from   
 knowing whether or not they received the omega-3 fats from fish oils. It is not   
 stated whether or not the evaluators of the “improvement” were blind to the   
 treatment, which would make the experiment double-blind.

h) Although it needs to be replicated, the experiment can determine whether or not   
 omega-3 fats from fish oils cause improvements in patients with bipolar disorder,   
 at least over the short term. The experiment design would be stronger is it were   
 double-blind.

22. a) This is an observational study. The researchers are simply studying traits that   
 already exist in the subjects, not imposing new treatments.

b) This is a prospective study. The subjects were identified first, then traits were   
 observed.

c) The subjects were disabled women aged 65 and older, with and without a   
 vitamin B-12 deficiency. The selection process is not stated.

d) The parameter of interest is the percentage of women in each group who   
 suffered severe depression.

e) There is no random assignment, so a cause-and-effect relationship between B-12   
 deficiency and depression cannot be established. The most that can be   
 determined is an association, if this is supported by the data.

23. a) This is an observational study. The researchers are simply studying traits that   
 already exist in the subjects, not imposing new treatments.

b) This is a prospective study. The subjects were identified first, then traits were   
 observed.

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c) The subjects are roughly 200 men and women with moderately high blood

pressure and normal blood pressure. There is no information about the selection   
method.

d) The parameters of interest are difference in memory and reaction time scores

between those with normal blood pressure and moderately high blood pressure.

e) An observational study has no random assignment, so there is no way to know   
 that high blood pressure caused subjects to do worse on memory and reaction   
 time tests. A lurking variable, such as age or overall health, might have been the   
 cause. The most we can say is that there was an association between blood   
 pressure and scores on memory and reaction time tests in this group, and   
 recommend a controlled experiment to attempt to determine whether or not   
 there is a cause-and-effect relationship.

24. a) This is an experiment, since treatments were imposed on randomly assigned   
 groups.

b) The subjects were 40 volunteers suffering from insomnia.

c) There are 2 factors in this experiment (dessert and exercise). The dessert factor   
 has 2 levels (no dessert and normal dessert). The exercise factor has 2 levels (no   
 exercise and an exercise program).

d) 2 factors, with 2 levels each, results in 4 treatments.

e) The response variable is improvement in ability to sleep.

f) This experiment is probably completely randomized.

g) This experiment does not use blinding.

h) This experiment indicates that insomniacs who exercise and refrain from desserts   
 will experience improved ability to sleep.

25. a) This is an experiment, since treatments were imposed on randomly assigned   
 groups.

b) 24 post-menopausal women were the subjects in this experiment.

c) There is 1 factor (type of drink), at 2 levels (alcoholic and non-alcoholic).

(Supplemental estrogen is not a factor in the experiment, but rather a blocking   
variable. The subjects were not given estrogen supplements as part of the   
experiment.)

d) 1 factor, with 2 levels, is 2 treatments.

e) The response variable is an increase in estrogen level.

f) This experiment utilizes a blocked design. The subjects were blocked by whether   
 or not they used supplemental estrogen. This design reduces variability in the   
 response variable of estrogen level that may be associated with the use of   
 supplemental estrogen.

g) This experiment does not use blinding.

h) This experiment indicates that drinking alcohol leads to increased estrogen level   
 among those taking estrogen supplements.

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26. a) This is an observational study.

b) The study is retrospective. Results were obtained from pre-existing medical   
 records.

c) The subjects in this study were 981 women who lived near the site of dioxin   
 release.

d) The parameter of interest is the incidence of breast cancer.

e) As there is no random assignment, there is no way to know that the dioxin levels   
 caused the increase in breast cancer. There may have been lurking variables that   
 were not identified.

27. a) This is an observational study.

b) The study is retrospective. Results were obtained from pre-existing church   
 records.

c) The subjects of the study are women in Finland. The data were collected from   
 church records dating 1640 to 1870, but the selection process is unknown.

d) The parameter of interest is difference in average lifespan between mothers of   
 sons and daughters.

e) For this group, having sons was associated with a decrease in lifespan of an   
 average of 34 weeks per son, while having daughters was associated with an   
 unspecified increase in lifespan. As there is no random assignment, there is no   
 way to know that having sons caused a decrease in lifespan.

28. a) This is an experiment, since treatments were imposed on randomly assigned   
 groups.

b) The subjects were volunteers exposed to a cold virus.

c) There is 1 factor (herbal compound), at 2 levels (herbal compound and sugar   
 solution).

d) 1 factor, at 2 levels, results in 2 treatments.

e) The response variable is the severity of cold symptoms.

f) There is no mention of any randomness is the design. Hopefully, subjects were   
 randomly assigned to treatment groups.

g) The experiment uses blinding. The use of a sugar solution as a placebo kept the   
 subjects from knowing whether or not they had received the herbal compound.   
 If the doctors responsible for assessing the severity of the patients’ colds were   
 also unaware of the treatment group assignments, then the experiment   
 incorporates double blinding.

h) There is no evidence to suggest that the herbal treatment is effective.

29. a) This is an observational study. (Although some might say that the sad movie   
 was “imposed” on the subjects, this was merely a stimulus used to trigger a   
 reaction, not a treatment designed to attempt to influence some response   
 variable. Researchers merely wanted to observe the behavior of two different   
 groups when each was presented with the stimulus.)

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b) The study is prospective. Researchers identified subjects, and then observed   
 them after the sad movie.

c) The subjects in this study were people with and without depression. The   
 selection process is not stated.

d) The parameter of interest is the difference in crying response between depressed   
 and nondepressed people exposed to sad situations.

e) There is no apparent difference in crying response to sad movies for the   
 depressed and nondepressed groups.

30. a) This is an experiment.

b) The subjects were racing greyhounds.

c) There is 1 factor (level of vitamin C in diet). The 3 levels of diet were not   
 specified.

d) One factor, at 3 levels, results in 3 treatments.

e) The response variable is speed.

f) The experiment uses a matched design. Each greyhound was given each of the 3   
 levels of diet, in random order. The matched design reduces variation due to the   
 racing ability of each greyhound.

g) There is no mention of blinding.

h) Greyhounds that eat diets high in vitamin C run more slowly than greyhounds   
 with diets lower in vitamin C.

31. a) This is an experiment. Subjects were randomly assigned to treatments.

b) The subjects were people experiencing migraines.

c) There are 2 factors (pain reliever and water temperature). The pain reliever   
 factor has 2 levels (pain reliever or placebo), and the water temperature factor   
 has 2 levels (ice water and regular water).

d) 2 factors, at 2 levels each, results in 4 treatments.

e) The response variable is the level of pain relief.

f) The experiment is completely randomized.

g) The subjects are blinded to the pain reliever factor through the use of a placebo.   
 The subjects are not blinded to the water factor. They will know whether they   
 are drinking ice water or regular water.

h) The experiment may indicate whether pain reliever alone or in combination with   
 ice water give pain relief, but patients are not blinded to ice water, so the placebo   
 effect may also be the cause of any relief seen due to ice water.

32. a) This is an experiment. Hopefully, dogs are randomly assigned to different   
 treatment groups.

b) The subjects are inactive dogs.