Questions on Topic Eight: Planning and Conducting Experiments

Multiple-Choice Questions

Directions: The questions or incomplete statements that follow are each followed by five suggested answers or completions. Choose the response that best answers the question or completes the statement.

1. A study is made to determine whether studying Latin helps students achieve higher scores on the verbal section of the SAT exam. In comparing records of 200 students, half of whom have taken at least 1 year of Latin, it is noted that the average SAT verbal score is higher for those 100 students who have taken Latin than for those who have not. Based on this study, guidance counselors begin to recommend Latin for students who want to do well on the SAT exam. Which of the following are true statements?
   
   I. While this study indicates a relation, it does not prove causation.
   II. There could well be a confounding variable responsible for the seeming relationship.
   III. Self-selection here makes drawing the counselors' conclusion difficult.

   (A) I and II
   (B) I and III
   (C) II and III
   (D) I, II, and III
   (E) None of the above gives the complete set of true responses.

2. In a 1927–32 Western Electric Company study on the effect of lighting on worker productivity, productivity increased with each increase in lighting but then also increased with every decrease in lighting. If it is assumed that the workers knew a study was in progress, this is an example of

   (A) the effect of a treatment unit.
   (B) the placebo effect.
   (C) the control group effect.
   (D) sampling error.
   (E) voluntary response bias.
3. When the estrogen-blocking drug tamoxifen was first introduced to treat breast cancer, there was concern that it would cause osteoporosis as a side effect. To test this concern, cancer subjects were randomly selected and given tamoxifen, and their bone density was measured before and after treatment. Which of the following is a true statement?

I. This study was an observational study.
II. This study was a sample survey of randomly selected cancer patients.
III. This study was an experiment in which the subjects were used as their own controls.

(A) I only
(B) II only
(C) III only
(D) I and II
(E) None of the above gives the complete set of true responses.

4. In designing an experiment, blocking is used

(A) to reduce bias.
(B) to reduce variation.
(C) as a substitute for a control group.
(D) as a first step in randomization.
(E) to control the level of the experiment.

5. Which of the following are true statements about blocking?

I. Blocking is to experiment design as stratification is to sampling design.
II. By controlling certain variables, blocking can make conclusions more specific.
III. The paired comparison design is a special case of blocking.

(A) I and II
(B) I and III
(C) II and III
(D) I, II, and III
(E) None of the above gives the complete set of true responses.

6. 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 allows hourly visits every day 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?

(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
7. A consumer product agency tests miles per gallon for a sample of automobiles using each of four different octanes of gasoline. Which of the following is true?

(A) There are four explanatory variables and one response variable.
(B) There is one explanatory variable with four levels of response.
(C) Miles per gallon is the only explanatory variable, but there are four response variables corresponding to the different octanes.
(D) There are four levels of a single explanatory variable.
(E) Each explanatory level has an associated level of response.

8. Which of the following are true statements?

I. In general, strong association implies causation.
II. In well-designed, well-conducted experiments, strong association implies causation.
III. Causation and association are unrelated concepts.

(A) I only
(B) II only
(C) III only
(D) I and II
(E) I, II, and III

9. Which of the following are true statements?

I. In well-designed observational studies, responses are systematically influenced during the collection of data.
II. In well-designed experiments, the treatments result in responses that are as similar as possible.
III. A well-designed experiment always has a single treatment but may test that treatment at different levels.

(A) I only
(B) II only
(C) III only
(D) II and III
(E) None of these statements is true.

10. Which of the following are important in the design of experiments?

I. Control of confounding variables
II. Randomization in assigning subjects to different treatments
III. Replication of the experiment using sufficient numbers of subjects

(A) I and II
(B) I and III
(C) II and III
(D) I, II, and III
(E) None of the above gives the complete set of true responses.
11. Which of the following are true about the design of matched-pair experiments?

I. Each subject might receive both treatments.
II. Each pair of subjects receives the identical treatment, and differences in their responses are noted.
III. Blocking is one form of matched-pair design.

(A) I only
(B) II only
(C) III only
(D) I and III
(E) II and III

12. A nutritionist believes that having each player take a vitamin pill before a game enhances the performance of the football team. During the course of one season, each player takes a vitamin pill before each game, and the team achieves a winning season for the first time in several years. Is this an experiment or an observational study?

(A) An experiment, but with no reasonable conclusion possible about cause and effect
(B) An experiment, thus making cause and effect a reasonable conclusion
(C) An observational study, because there was no use of a control group
(D) An observational study, but a poorly designed one because randomization was not used
(E) An observational study, thus allowing a reasonable conclusion of association but not of cause and effect

13. 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) An experiment with control group and blinding
(B) An experiment with blocking
(C) An observational study with comparison and randomization
(D) An observational study with little if any bias
(E) None of the above

Answer Key

Answers Explained

1. (D) It may well be that very bright students are the same ones who both take Latin and do well on the SAT verbal exam. If students could be randomly assigned to take or not take Latin, the results would be more meaningful. Of course, ethical considerations might make it impossible to isolate the confounding variable in this way.

2. (B) The desire of the workers for the study to be successful led to a placebo effect.

3. (C) In experiments on people, the subjects can be used as their own controls, with responses noted before and after the treatment. However, with such designs there is always the danger of a placebo effect. Thus the design of choice would involve a separate control group to be used for comparison.

4. (B) Blocking divides the subjects into groups, such as men and women, or political affiliations, and thus reduces variation.

5. (D) Blocking in experiment design first divides the subjects into representative groups called blocks, just as stratification in sampling design first divides the population into representative groups called strata. This procedure can control certain variables by bringing them directly into the picture, and thus conclusions are more specific. The paired comparison design is a special case of blocking in which each pair can be considered a block.

6. (E) None of the studies has any controls, such as randomization, control groups, or blinding, and so while they may give valuable information, they cannot establish cause and effect.

7. (D) Octane is the only explanatory variable, and it is being tested at four levels. Miles per gallon is the single response variable.

8. (B) Well-designed experiments can show cause and effect.

9. (E) In good observational studies, the responses are not influenced during the collecting of data. In good experiments, treatments are compared as to differences in responses. In an experiment, there can be many treatments, each at a different level.

10. (D) Control, randomization, and replication are all important aspects of well-designed experiments.

11. (A) Each subject might receive both treatments, as, for example, in the Pepsi-Coke taste comparison study. The point is to give each subject in a matched pair a different treatment and note any difference in responses. Matched-pair experiments are a particular example of blocking, not vice versa.
12. (A) This study was an experiment because a treatment (vitamin pills) was imposed on the subjects. However, it was a poorly designed experiment with no use of randomization and no control over lurking variables, and so the results are meaningless.

13. (E) This study is an experiment because a treatment (periodic removal of a pint of blood) is imposed. There is no blinding because the subjects clearly know whether or not they are giving blood. There is no blocking because the subjects are not divided into blocks before random assignment to treatments. For example, blocking would have been used if the subjects had been separated by gender or age before random assignment to give or not give blood donations.

Free-Response Questions

Directions: You must show all work and indicate the methods you use. You will be graded on the correctness of your methods and on the accuracy of your final answers.

Eleven Open-Ended Questions

1. Some health care professionals recommend the use of melatonin to promote better sleep patterns. To test this idea the manufacturer has 100 of its employees fill out a questionnaire about their sleeping patterns, once at the beginning of the study and then again after taking a 3-milligram melatonin capsule every night at bedtime for a week. Comment on the design of this experiment.

2. Suppose a new drug is developed that appears in laboratory settings to completely prevent people who test positive for human immunodeficiency virus (HIV) from ever developing full-blown acquired immunodeficiency syndrome (AIDS). Putting all ethical considerations aside, design an experiment to test the drug. What ethical considerations might arise during the testing that would force an early end to the experiment?

3. A new weight-loss supplement is to be tested at three different levels (once, twice, and three times a day). Design an experiment, including a control group and including blocking for gender, for 80 overweight volunteers, half of whom are men. Explain carefully how you will use randomization.

4. Two studies are run to measure the health benefits of long-time use of daily high doses of vitamin C. Researchers in the first study send a questionnaire to all 50,000 subscribers to a health magazine, asking whether they have taken large doses of vitamin C for at least a 2-year period and what they perceive to be the health benefits, if any. The response rate is 80%. The 10,000 people who did not respond to the first mailing receive follow-up telephone calls, and eventually responses are registered from 98% of the magazine subscribers. Researchers in a second study take a group of 200 volunteers and randomly