Experiment Problems

1-18. What's the design? Read each brief report of statistical research, and identify:
   a) whether it was an observational study or an experiment.
   b) if it was an investigative study, identify (if possible)
      c) the subjects studied, and how they were selected.
      d) the parameter of interest.
      e) the nature and scope of the conclusion the study can reach
   If it was an experiment, identify (if possible)
      b) the subjects studied.
      c) the factor(s) in the experiment, and the number of levels for each.
      d) the number of treatments.
      e) the response variable measured.
      f) the design (completely randomized, blocked, or matched).
      g) whether it was blind (or double-blind).
      h) the nature and scope of the conclusion the experiment can reach.

1. Over a 4-month period, among 30 people with bipolar disorder, patients who were given a high dose (10 g/day) of omega-3 fats from fish oil improved more than those given a placebo. (Archives of General Psychiatry 56 [1999]: 407)

2. The leg muscles of men aged 60 to 75 were 50% to 80% stronger after they participated in a 16-week, high-intensity resistance-training program twice a week. (Journal of Gerontology 55 A [2000]: B336)

3. In a test of roughly 200 men and women, those with moderately high blood pressure (averaging 164/89 mm Hg) did worse on tests of memory and reaction time than those with normal blood pressure. (Hypertension 36 [2000]: 1079)

4. Among a group of disabled women aged 65 and older who were tracked for several years, those who had a vitamin B₁₂ deficiency were twice as likely to suffer severe depression as those who did not. (American Journal of Psychology 157 [2000]: 715)

5. An examination of the medical records of more than 360,000 Swedish men showed that those who were overweight or who had high blood pressure had a higher risk of kidney cancer. (New England Journal of Medicine 3434 [2000]: 1305)

6. To research the effects of "dietary patterns" on blood pressure in 459 subjects, subjects were randomly assigned to three groups and had their meals prepared by dieticians. Those who were fed a diet low in fat and cholesterol and high in fruits, vegetables, and low-fat dairy foods (known as the DASH diet) lowered their systolic blood pressure by an average of 6.7 points when compared with subjects fed a control diet.

7. After menopause many women take supplemental estrogen. There is some concern that if these women also drink alcohol their estrogen levels will rise too high. Twenty-four volunteers, 12 who were receiving supplemental estrogen and 12 who were not, were randomly divided into two groups. One group drank an alcoholic beverage, the other a nonalcoholic beverage. An hour later everyone's estrogen level was checked. Only those on supplemental estrogen who drank alcohol showed a marked increase.

8. Is diet or exercise effective in combating insomnia? Some believe that cutting out desserts can help alleviate the problem, while others recommend exercise. Forty volunteers suffering from insomnia agreed to participate in a month-long experiment. Half were randomly assigned to a special no-desserts diet; the others continued desserts as usual. Half of the people in each of these groups were randomly assigned to an exercise program, while the others did not exercise. Those who ate no desserts and engaged in exercise showed the most improvement.

9. Some gardeners prefer to use nonchemical methods to control insect pests in their gardens. Researchers have designed two kinds of traps, and want to know which design will be more effective. They randomly choose 10 locations in a large garden and place one of each kind of trap at each location. After a week they count the number of bugs in each trap.

10. Researchers have linked an increase in the incidence of breast cancer in Italy to dioxin released by an industrial accident in 1976. The study identified 981 women who lived near the site of the industrial explosion and were under age 40 at the time. Fifteen of the women had developed breast cancer, at an unusually young average age of 45. Medical records showed that these women had heightened concentrations of dioxin in their blood, and that each 10-fold increase in dioxin level was associated with a doubling of the risk of breast cancer. (Science News, Aug. 3, 2002)
11. In 2002 the journal Science reported that a study of women in Finland indicated that having sons shortened the lifespans of mothers by about 34 weeks per son, but that daughters helped to lengthen the mothers' lives. The data came from church records from the period 1640 to 1870.

12. In 2001 a report in the Journal of the American Cancer Institute indicated that women who work nights have a 60% greater risk of developing breast cancer. Researchers based these findings on the work histories of 763 women with breast cancer and 741 women without the disease.

13. The May 4, 2000, issue of Science News reported that, contrary to popular belief, depressed individuals cry no more often in response to sad situations than nondepressed people. Researchers studied 23 men and 48 women with major depression, and 9 men and 24 women with no depression. They showed the subjects a sad film about a boy whose father has died, noting whether or not the subjects cried. Women cried more often than men, but there were no significant differences between the depressed and nondepressed groups.

14. Scientists at a major pharmaceutical firm investigated the effectiveness of an herbal compound to treat the common cold. They exposed each subject to a cold virus, then gave him or her either the herbal compound or a sugar solution known to have no effect on colds. Several days later they assessed the patient's condition, using a cold severity scale ranging 0 to 5. They found no evidence of benefits associated with the compound.

15. Scientists examined the glycogen content of rats' brains at the rats' normal bedtimes and after they had been kept awake for an extra 6, 12, or 24 hours. The scientists found that glycogen was 38% lower among rats that had been sleep-deprived for 12 hours or more, and that the levels recovered during subsequent sleep. These researchers speculate that we may need to sleep in order to restore the brain's energy fuel. (Science News, July 20, 2002)

16. Some people who race greyhounds give the dogs large doses of vitamin C in the belief that the dogs will run faster. Investigators at the University of Florida tried three different diets in random order on each of five racing greyhounds. They were surprised to find that when the dogs ate high amounts of vitamin C they ran more slowly. (Science News, July 20, 2002)

17. Some people claim they can get relief from migraine headache pain by drinking a large glass of ice water. Researchers plan to enlist several people who suffer from migraines in a test. When a participant experiences a migraine headache, he or she will take a pill that may be a standard pain reliever or a placebo. Half of each group will also drink ice water. Participants will then report the level of pain relief they experience.

18. Weight is an issue for both humans and their pets. A dog food company wants to compare a new lower-calorie food with their standard dog food to see if it's effective in helping inactive dogs maintain a healthy weight. They have found several dog owners willing to participate in the trial. The dogs have been classified as small, medium, or large breeds, and the company will supply some owners of each size of dog with one of the two foods. The owners have agreed not to feed their dogs anything else for a period of 6 months, after which the dogs' weights will be checked.

19. Tomatoes. Describe a strategy to randomly split the 24 tomatoes into the three groups for the chapter's completely randomized single factor test of OptiGro fertilizer.

20. Tomatoes II. The chapter also described a completely randomized two-factor experiment testing OptiGro fertilizer in conjunction with two different routines for watering the plants. Describe a strategy to randomly assign the 24 tomato plants to the six treatments.

21. Mozart. Will listening to a Mozart piano sonata make you smarter? In a 1995 study, Rauscher, Shaw, and Ky reported that when students were given a spatial reasoning section of a standard IQ test, those who listened to Mozart for 10 minutes improved their scores more than those who simply sat quietly. a) These researchers said the differences were statistically significant. Explain what that means in this context.
   b) Steele, Bass, and Crook tried to replicate the original study. The subjects were 125 college students who participated in the experiment for course credit. Subjects first took the test. Then they were assigned to one of three groups: listening to a Mozart piano sonata, listening to music by Philip Glass, and sitting for 10 minutes in silence. Three days after the treatments, they were retested. Draw a diagram displaying the design of this experiment. c) The boxplots show the differences in score before and after treatment for the three groups. Did the Mozart group show improvement?
d) Do you think the results prove that listening to Mozart is beneficial? Explain.

22. More Mozart. An advertisement selling specially designed music CDs of Mozart's music specifically because they will "strengthen your mind, heal your body, and unlock your creative spirit" claims (we swear!) that "In Japan, a brewery reports that their best sake is made when Mozart is played near the yeast." Suppose, just for the sake (as it were) of discussion, you wished to design an experiment to test whether this is true. Assume you have the full cooperation of the sake brewery. Specify how you would design the experiment. Indicate factors and response and how they would be measured, controlled, or randomized.

23. Frumpies. The makers of Frumpies, "the breakfast of rug rats," want to improve their marketing, so they consult you:
   a) They first want to know what fraction of children, ages 10 to 13, like their celery-flavored cereal. What kind of study should they perform?
   b) They are thinking of introducing a new flavor, maple-marshmallow Frumpies, and want to know whether children will prefer the new flavor to the old one. Design a completely randomized experiment to investigate this question.
   c) They suspect that children who regularly watch the Saturday morning cartoon show staring Frump, the flying teenage warrior rabbit who eats Frumpies in every episode, may respond differently to the new flavor. How would you take that into account in your design?

24. Full moon. It's a common belief that people behave strangely when there's a full moon, and that as a result police and emergency rooms are busier than usual. Design a way you could find out if there is any merit to this belief. Will you use an observational study or an experiment? Why?

25. Health. A 2001 Danish study published in the Archives of Internal Medicine casts significant doubt on suggestions that adults who drink wine have higher levels of "good" cholesterol and fewer heart attacks. These researchers followed a group of individuals born at a Copenhagen hospital between 1959 and 1961 for 40 years. Their study found that in this group the adults who drank wine were richer and better educated than those who did not.
   a) What kind of study was this?
   b) It is generally true that people with high levels of education and high socioeconomic status are healthier than others. How does this call into question the supposed health benefits of wine?
   c) Can studies such as these prove causation (that wine helps prevent heart attacks, that drinking wine makes one richer, that being rich helps prevent heart attacks, etc.)? Explain.

26. Swimming. Recently, a group of adults who swim regularly for exercise were evaluated for depression. It turned out that these swimmers were less likely to be depressed than the general population. The researchers said the difference was statistically significant.
   a) What does "statistically significant" mean in this context?
   b) Is this an experiment or an observational study? Explain.
   c) News reports claimed this study proved that swimming can prevent depression. Explain why this conclusion is not justified by the study. Include an example of a possible confounding variable.
   d) But perhaps it is true. We wonder if exercise can ward off depression, and whether anaerobic exercise (like weight training) is as effective as aerobic exercise (like swimming). We find 120 volunteers not currently engaged in a regular program of exercise. Design an appropriate experiment.

27. Dowsing. A water dowser claims to be able to sense the presence of water using a forked stick. Suppose we wish to set up an experiment to test his ability. We get 20 identical containers, fill some with water, and ask the dowser to tell which ones are full and which empty.
   a) How will we randomize this procedure?
   b) The dowser correctly identifies the contents of 12 out of 20 containers. Do you think this level of success is statistically significant? Explain.
   c) How many correct identifications (out of 20) would the dowser have to make to convince you that the forked stick trick works? Explain.

28. Healing. A medical researcher suspects that giving post-surgical patients large doses of vitamin E will speed their recovery time by helping their incisions heal more quickly. Design an experiment to test this conjecture. Be sure to identify the factors, levels, treatments, response variable, and the role of randomization.
29. Reading. Some schools teach reading using phonics (the sounds made by letters) and others using whole language (word recognition). Suppose a school district wants to know which method works better. Suggest a design for an appropriate experiment.

30. Gas mileage. Do cars get better gas mileage with premium instead of regular unleaded gasoline? While it might be possible to test some engines in a laboratory setting, we'd rather use real cars and real drivers in real day-to-day driving, so we get 20 volunteers. Design the experiment.

31. Weekend deaths. A study published in the New England Journal of Medicine (Aug. 2001) suggests that it's dangerous to enter a hospital on a weekend. During a 10-year period, researchers tracked over 4 million emergency admissions to hospitals in Ontario, Canada. Their findings revealed that patients admitted on weekends had a much higher risk of death than those who went to the emergency room on weekdays.
   a) The researchers said the difference in death rates was "statistically significant." Explain in this context what that means.
   b) What kind of study was this? Explain.
   c) If you think you're quite ill on a Saturday, should you wait until Monday to seek medical help? Explain.
   d) Suggest some possible explanations for this troubling finding.

32. Shingles. A research doctor has discovered a new ointment that she believes will be more effective than the current medication in the treatment of shingles (a painful skin rash). Eight patients have volunteered to participate in the initial trials of this ointment. You are the statistician hired as a consultant to help design a completely randomized experiment.
   a) Describe how you will conduct this experiment.
   b) Suppose the eight patients' last names start with the letters A to H. Using the random numbers listed below, show which patients you will assign to each treatment. Explain your randomization procedure clearly.
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   c) Can you make this experiment double blind? If so, explain how.
   d) The initial experiment revealed that males and females may respond differently to the ointment. Further testing of the drug's effectiveness is now planned, and many patients have volunteered. What changes in your first design, if any, would you make for this second stage of testing?

33. Beetles. Hoping to learn how to control crop damage by a certain species of beetle, a researcher plans to test two different pesticides in small plots of corn. A few days after application of the chemicals, he'll check the number of beetle larvae found on each plant. The researcher wants to know if either pesticide works, and whether there is a significant difference in effectiveness between them. Design an appropriate experiment.

34. SAT Prep. Can special study courses actually help raise SAT scores? One organization says that the 30 students they tutored achieved an average gain of 60 points when they retook the test.
   a) Explain why this does not necessarily prove that the special course caused the scores to go up.
   b) Propose a design for an experiment that could test the effectiveness of the tutorial course.
   c) Suppose you suspect that the tutorial course might be more helpful for students whose initial scores were particularly low. How would this affect your proposed design?

35. Safety switch. An industrial machine requires an emergency shutoff switch that must be designed so that it can be easily operated with either hand. Design an experiment to find out whether workers will be able to deactivate the machine as quickly with their left hands as with their right hands. Be sure to explain the role of randomization in your design.
Answers:

1. a) Experiment.  
b) Bipolar disorder patients.  
c) Omega-3 fats from fish oil, 1 level.  
d) 1 treatments.  
e) Improvement (fewer symptoms?).  
f) Design not specified.  
g) Blind (due to placebo), unknown if double-blind  
h) Individuals with bipolar disease improve with high-dose omega-3 fats from fish oil.

2. a) Experiment.  
b) Men aged 60 to 75.  
c) Exercise (1 level).  
d) 1 treatment, 16-week, high-intensity resistance training twice a week.  
e) Strength levels pre- and postexercise program.  
f) Pre- and posttest-matched design.  
g) Not blinded.  
h) Applies only to men 60 to 75 who participate in similar exercise programs. However, since there is no random assignment, other factors might have explained the difference in strength.

3. a) Observational study.  
b) Prospective.  
c) Men and women with moderately high blood pressure and normal blood pressure, unknown selection process.  
d) Memory and reaction time.  
e) As there is no random assignment, there is no way to know that high blood pressure caused subjects to do worse on memory and reaction time tests. A lurking variable may also be the cause.

4. a) Observational study.  
b) Prospective.  
c) Disabled women aged 65 and older with and without a vitamin B12 deficiency, unknown selection process.  
d) Suffering severe depression.  
e) As there is no random assignment, there is no way to know that the deficiency caused the severe depression.

5. a) Observational study.  
b) Retrospective.  
c) Swedish men, unknown selection process;  
d) Risk of kidney cancer.  
e) As there is no random assignment, there is no way to know that the overweight or high blood pressure caused the higher risk for kidney cancer.

6. a) Experiment.  
b) 459 subjects.  
c) Diet with 3 levels.  
d) 3 treatments (3 groups—but only one diet and one control group were described).

7. a) Experiment.  
b) Postmenopausal women.  
c) Alcohol — levels; blocking variable—estrogen supplements (levels).  
d) 2 treatments X 2 blocking levels.  
e) Increase in estrogen levels.  
f) Blocked.  
g) Not blind.  
h) Indicates that alcohol consumption for those taking estrogen supplements may increase estrogen levels.

8. a) Experiment.  
b) People suffering from insomnia.  
c) 2 factors: desserts and exercise (2 levels each).  
d) 4 treatments.  
e) Improvement in ability to sleep.  
f) Completely randomized.  
g) Not blind.  
h) Insomniacs who exercise and refrain from desserts will experience improved ability to sleep.

9. a) Experiment.  
b) Locations in a garden.  
c) 1 factor: traps (2 levels).  
d) 2 treatments.  
e) Number of bugs in the trap.  
f) Blocked by location.  
g) Not blind.  
h) One type of trap is more effective than the other.

10. a) Observational study.  
b) Retrospective.  
c) Women exposed to dioxin from an industrial accident.  
d) Risk 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.

11. a) Observational study.  
b) Retrospective.  
c) Women in Finland, unknown selection process with data from church records.  
d) Lifespans.  
e) As there is no random assignment, there is no way to know that having sons or daughters shortens or lengthens the lifespan of mothers.

12. a) Observational study.  
b) Retrospective.
c) Women; unknown selection process with information taken from work histories.
d) Risk of breast cancer.
e) As there is no random assignment, there is no way to know that working nights caused breast cancer; there may be confounding variables not identified in the study.

13. a) Observational.
   b) Prospective.
   c) People with or without depression, unknown selection process.
   d) Crying response to sad situations.
   e) There is no apparent difference in crying response (to sad movies) for depressed and nondepressed groups.

14. a) Experiment.
   b) People exposed to cold virus.
   c) 1 factor: herbal treatment (2 levels).
   d) 2 treatments.
   e) Severity of cold symptoms.
   f) No discussion of randomness.
   g) Blind, as subjects did not know if they received the herbal treatment or the placebo. Not clear if it was double-blind.
   h) There is no indication that the herbal treatment is effective.

15. a) Experiment.
   b) Rats.
   c) 1 factor: sleep deprivation; four levels.
   d) 4 treatments.
   e) Glycogen content in the brain.
   f) No discussion of randomness.
   g) Blinding is not discussed.
   h) The conclusion could be that rats deprived of sleep have significantly lower glycogen levels and may need sleep to restore that brain energy fuel. Extrapolating to humans would be very speculative.

16. a) Experiment.
   b) Racing greyhounds.
   c) 1 factor, diet with 3 levels.
   d) 3 treatments.
   e) Speed.
   f) Random assignment to order of diets; matched design before and after diet.
   g) No blinding.
   h) Greyhounds who eat diets high in vitamin C run more slowly.

17. a) Experiment.
   b) People experiencing migraines.
   c) 2 factors (pain reliever and water temperature), 2 levels each.
   d) 4 treatments.
   e) Level of pain relief.
   f) Completely randomized over 2 factors.
   g) Blind, as subjects did not know if they received the pain medication or the placebo, but not blind, as the subjects will know if they are drinking regular or ice water.
   h) It may indicate whether pain reliever alone or in combination with ice water gives pain relief, but patients are not blinded to ice water, so placebo effect may also be the cause of any relief seen due to ice water.

18. a) Experiment.
   b) Inactive dogs.
   c) 1 factor: dog food (assuming amount of food to be determined by weight or size of dog) (2 levels).
   d) 2 treatments.
   e) Weight.
   f) Blocked by size of breed.
   g) Blinded, assuming dog owners do not know which food the dog is receiving.
   h) Assuming the dog owners followed the prescribed feeding levels, there could be a conclusion as to whether or not the dog food helped maintain healthy weight.

19. Answers may vary. Use a random number generator to randomly select 24 numbers from 1 to 24 without replication. Assign the first 8 numbers to the first group, the second 8 numbers to the second group, and the third group of 8 numbers to the third group.

20. Answers may vary. Use a random number generator to randomly select 24 numbers from 1 to 24 without replication. Assign the first group of 4 numbers to the first treatment (no fertilizer, natural watering), the second group of 4 numbers to the second treatment (no fertilizer, daily water), the third group of 4 numbers to the third treatment (half fertilizer, natural watering), and so on to the sixth treatment.

21. a) The differences among the Mozart and quiet groups were more than would have been expected from ordinary sampling variation.
   b) The differences among the Mozart and quiet groups were more than would have been expected from ordinary sampling variation.

   ![Diagram](attachment:diagram.png)

   c) The Mozart group seems to have the smallest median difference and thus the least improvement, but there does not appear to be a significant difference.
d) No, if anything there is less improvement, but the difference does not seem significant compared with the usual variation.

22. Answers may vary. Suppose you select the next 12 batches of sake for the experiment. Divide the yeast into two parts. For each batch, play Mozart for half the yeast and no Mozart for the other half. When the sake is done, have trained sake testers (who don’t know which experimental treatment was applied) taste samples from each group and rate the sake. Compare the ratings for the Mozart and the non-Mozart sake. Try to keep as many other variables as possible under control (type of yeast, size of batch, etc.)

23. a) Observational. Randomly select a group of children, ages 10 to 13, have them taste the cereal, and ask if they like the cereal.

b) Answers may vary. Get volunteers age 10 to 13. Each volunteer will taste both cereals, randomizing the order in which they taste them. Compare the percentage of favorable ratings for each cereal.

c) Answers may vary. From the volunteers, identify the children who watch Frump and identify the children who do not watch Frump. Use a blocked design to reduce variation in cereal preference that may be associated with watching the Frump cartoon.

24. Use a retrospective observational study. For example, collect records from a random selection of police and emergency room logs for the past 3 years. Find the number of cases for the days when there is a full moon, when there is a waxing moon, a waning moon, and when the moon is nearly dark. Compare the numbers for each group.

25. a) Observational, prospective study.

b) The supposed relation between health and wine consumption might be explained by the confounding variables of income and education.

c) None of these. While the variables have a relation, there is no causality indicated for the relation.

26. a) The difference in the depression rates for the two groups is greater than would be expected by natural sampling variation.

b) Observational study. There was no experimental treatment.

c) The difference could be explained by lurking variables. Perhaps swimmers are more affluent (can afford a membership at the Y or have access to a pool), or perhaps depressed people tend to swim less.

d) Answers may vary. Give the subjects a test to measure depression. Then randomly assign the 120 subjects to one of three groups: the control group (no exercise program), the anaerobic exercise group, and the aerobic exercise group. Monitor subjects’ exercise (have them report to a particular gym or pool). At the end of 12 weeks, administer the depression test again. Compare the postexercise and preexercise depression scores.

27. a) Arrange the 20 containers in 20 separate locations. Use a random number generator to identify the 10 containers that should be filled with water.

b) Guessing, the dowser should be correct about 50% of the time. A record of 60% (12 out of 20) does not appear to be significantly different.

c) Answers may vary. You would need to see a high level of success—say, 90% to 100%, that is, 18 to 20 correct.

28. Answers may vary. Randomly select half of the patients who agree to the study to get large doses of vitamin E after surgery. Give the other half a similar-looking placebo pill. Monitor their progress, recording the time until they have reached an easily agreed upon level of healing. Have the evaluating doctor blinded to whether the patient received the placebo or not. Compare the number of days until recovery of the two groups.

29. Randomly assign half the reading teachers in the district to use each method. Students should be randomly assigned to teachers as well. Make sure to block both by school and grade (or control grade by using only one grade). Construct an appropriate reading test to be used at the end of the year and compare scores.

30. Answers may vary. This experiment has 1 factor (type of gasoline), at 2 levels (premium and regular), resulting in two treatments. The response variable is gas mileage. An experiment diagram for a matched design appears above. Have each of the volunteers use each kind of gas for a month. Randomly assign 10 of them to use regular first, the other 10 to use premium first. Ask them to keep driving logs (the number of miles driven and the gallons
31. a) They mean that the difference is higher than they would expect from normal sampling variability.
b) An observational study.
c) No. Perhaps the differences are due to some confounding variable (like people are more likely to engage in riskier behaviors on the weekend) rather than due to the day of admission.
d) Perhaps people have more serious accidents and traumas on weekends and are thus more likely to die as a result.

32. a) Answers may vary. Randomly assign the eight patients to either the current medication or the new medication. Have nurses assess the degree of shingles involvement for the patient. Ask patients to rate their pain levels. Administer the medications for a prescribed time. Have nurses reassess the degree of shingles involvement. Ask patients to rate their pain levels post medication. Compare the improvement levels for each group.
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   Let A = 1, B = 2...H = 8.
   Assign the first four randomly selected to the first group, the remainder to the second. So Group 1 is D, A, H, C and Group 2 is B, E, F, G.
c) Assuming that the ointments look alike, it would be possible to blind the experiment for the subject and for the administrator of the treatment.
d) A block design with factors for gender and for ointment would be appropriate. Subjects would be randomly assigned to each treatment group in the blocked design.

33. Answers may vary. This experiment has 1 factor (pesticide), at 3 levels (pesticide A, pesticide B, no pesticide), resulting in 3 treatments. The response variable is the number of beetle larvae found on each plant. Randomly select a third of the plots to be sprayed with pesticide A, a third with pesticide B, and a third to be sprayed with no pesticide (since the researcher also wants to know whether the pesticides even work at all). To control the experiment, the plots of land should be as similar as possible, with regard to amount of sunlight, water, proximity to other plants, etc. If not, plots with similar characteristics should be blocked together. If possible, use some inert substance as a placebo pesticide on the control group, and do not tell the counters of the beetle larvae which plants have been treated with pesticides. After a given period of time, count the number of beetle larvae on each plant and compare the results.

34. a) The students were not randomly assigned. Those who signed up for the prep course may be a special group whose scores would have improved anyway.
b) Answers may vary. Find a group of volunteers who are willing to participate. Give all volunteers the SAT exam. Randomly assign the subjects to the review or no review group. Give the tutoring to the one group. After a reasonable time, retest both groups. Check to see that the tutored group had a significant improvement in scores when compared with the no review group.
c) After the volunteers have taken the first SAT exam, separate the volunteers into blocks of low, average, and high SAT exam score performance. Now assign half of each block to the review and half to the no review groups. Give the tutoring. Now retest all groups. Compare the differences between treatments for each block.

35. Answers may vary. Find a group of volunteers. Each volunteer will be required to shut off the machine with his or her left hand and the right hand. Randomly assign the left or right hand to be used first. Complete the first attempt for the whole group. Now repeat the experiment with the alternate hand. Check the differences in time for the left and right hands.