Lesson 4.2.2

4-63. a. Example: The explanatory variable is the app and the response variable will be the change in fitness scores. Subjects will be randomly assigned to one of two treatments: BioNomial app or free app. All subjects will take a fitness test before and after and researchers will compare the average change in test scores for the two treatments.

b. No. The median for the BioNomial app appears to be a tiny bit higher than the median of the free app, but just barely and the overall graphs overlap significantly. The only reasonable evidence is that the max and min of the BioNomial app group are both higher than the free app group, but with so much variability that is thin evidence indeed.

c. Since the median for the BioNomial app is so much higher than the median for the free app, and the third quartile of the free app is actually lower than the median of the BioNomial app, this boxplot seems to provide a much more compelling case.

d. Answers vary.

e. About 30%; yes, answers may vary.

f. People respond very differently to the apps so switching them between treatment groups shows the variation due to random chance and how uncertain the results are.

g. The variability is very high, which results in some good boxplots and some bad boxplots, and even the good ones are difficult to read.

h. Separate the volunteers by common variables which are confounding the results and run separate experiments.

4-64. a. Blocking by age should not make much of a difference; variability will still be high. It is not actually a confounding variable in this experiment. The IQRs of the individual boxplots will be very similar to the original unblocked boxplots.

b. The variability of the boxplots should decrease *significantly* with this variable, and the BioNomial app will hopefully quite consistently show up as better than the free app. This is a major confounding variable!

c. The combination of Previous Workout Level and Competitive Nature reduces the variability to almost nothing and should show a very consistent advantage for the BioNomial app over the free app.

4-65. a. Example: Taller people probably have longer strides and will cover a distance of 30 feet in a shorter period of time than people who are not as tall. Assuming the subjects are randomly assigned to treatments, the effects of those treatments may be hidden by the variation due to height differences. Alternatively: Some people are better at multi-tasking than others. Assuming the subjects are randomly assigned to treatments, the variability among subjects due to their ability to multi-task will make it difficult to observe a difference in results among treatment groups.

b. Answers will vary but should include blocking on the variables mentioned in part (a).

4-66. a. *i*: Explanatory: smell of sunscreen or no smell of sunscreen; response: blood pressure reading. Confounding variables: other smells, diet, consumption of alcohol, family history of high blood pressure.

ii: It will be impossible to keep the subjects from knowing that they have been exposed to the smell of sunscreen. However, it is reasonable to request that the researchers be kept in the dark about which treatment group each subject belongs to. Therefore, the experiment could be blind.

iii: It would be easy to add a placebo, or another smell to the experiment to act as a form of control.

iv: The subjects could be blocked according to their pre-existing blood pressure levels: high blood pressure vs. normal blood pressure. The experiment might then detect differences in the reduction between groups. Because blood pressure levels vary from one person to another, a matched pairs design might provide additional control and account for the variability from subject to subject.

b. *i*: Explanatory: listening to music or not listening to music; response: amount learned. Confounding variables: other study techniques used, pre-existing knowledge of the subject being studied.

ii-iii: It would be impossible to keep the subjects from know whether they listened to music or not. The treatments could, however, be assigned without the knowledge of the researchers, who simply need to measure the amount learned at the start of the experiment and then compare that to the amount learned at the end.

iv: The subjects could be blocked according to the study techniques they use. This would reduce the variability between subjects due to the way that they choose to learn. Because individuals differ in the time it takes to learn, a matched pairs design might be preferable as it would reduce the variability among subjects.

c. *i*: Explanatory: eating or not eating slow-digesting carbs; response: endurance as measured by a variety of variables like heart rate, oxygen intake, muscle fatigue. Confounding variables: overall physical condition.

ii: It would be impossible to make the experiment blind, the subjects will know what they are eating. However, the researchers do not need to know which treatment the subjects were assigned to in order to measure the variables that make up endurance.

iii: A placebo is not necessary, only a control group not eating slow-digesting carbs to compare to.

iv: Subjects could be blocked based upon their prior physical condition. The variability among subjects could be reduced by grouping them according to physical condition. A matched pairs design would improve the overall design and reduce the variability from subject to subject. Both treatments would be applied to each subject, the order of which would be randomized.

4-67. Blocks should be created based upon the amount of musical training a subject has. All subjects will take a sight-reading test prior to the treatment phase of the experiments. Within each block, randomly assign subjects to either take lessons from a live instructor or a computer program for a set amount of time. At the end of the treatment period, all subjects will again take a sight-reading test and the change in scores will be recorded. The average change in scores for each treatment should then be compared within each block to determine the effect of the two kinds of lessons on sight-reading.

4-68. Students will be most likely to respond to this survey because they have strong feelings about extending the school year into summer vacation. The online survey is likely to get a strong negative response to the survey.

4-69. Both equal $\frac{3}{8}$.

4-70. a. The residual is 0.83 points. The student who studied 10 hours earned a GPA 0.83 points higher than predicted. A student would prefer a positive residual because it would mean that they earned a higher GPA than was predicted from the number of hours spent studying.

b. S is the standard deviation of the residuals. 0.6496 means that the typical GPA is about 0.6496 points away from the value predicted by the LSRL.

c. One reasonable method is to look for the biggest residual. Another option, easier with the information given, is to use a width of $2S$ in each direction to create a margin of error. The LSRL estimate for the GPA of a student who studies 8 hours is 3.47 points. Using $2S = 1.30$ gives a GPA estimate range of 2.17 to 4.77 points. This is not particularly useful on a 5-point GPA scale (as implied by these numbers).

4-71. a. They should notice that Facegram hours are increasing while Twillerpage hours are decreasing. Instant Book hours only increase in the last month. Students might make a connection that more people are using Facegram around the holidays.

b.

	October	November	December
Facegram	50%	60%	65%
Twillerpage	30%	20%	10%
Instant Book	20%	20%	25%

