

Part II Review Exercises

II.1 (a) Yes—the researchers used double blinding in this experiment. Since the subjects did not know what kind of toothpaste they were using (unmarked tubes were used) and the dentists did not know which subjects were using which toothpaste, both groups were blind as to which group each subject was in.

(b) The researchers gave all of the volunteers a free tooth cleaning so that the volunteers' teeth would all be free of tartar buildup at the beginning of the study.

(c) Suppose the researchers believe that men's and women's dental hygiene habits differ systematically. For instance, maybe women tend to brush more frequently and more thoroughly than men do. Then the researchers could block the volunteers by gender. They should randomly assign 60 men to the tartar control group and 60 men to the regular toothpaste group. For the women, 45 would be randomly assigned to the tartar control group and 45 to the regular toothpaste group. Blocking in this way would isolate the unwanted variability due to gender differences in dental hygiene that is present in the completely randomized design.

II.2 (a) A potential source of bias related to the question wording is that people may not remember how many movies they watched in a movie theater in the past year. It might help the polling organization to shorten the amount of time that they ask about, perhaps 3 or 6 months.

(b) A potential source of bias not related to the question wording is that the poll contacted people through "residential phone numbers." Since more and more people (especially younger adults) are using only a cellular phone (and do not have a residential phone), the poll omitted these people from the sampling frame. These same people might be more likely to watch movies in a movie theater. The polling organization should include cell phone numbers in their list of possible numbers to call.

II.3 (a) This was an observational study. The researchers examined data from the nurses, including their alcohol consumption. The researchers did not assign the nurses to different alcohol consumption groups—these were preexisting groups, and the researchers observed the results. (b) "Significantly lower risk of death" means that the light-to-moderate drinkers had lower death rates than both nondrinkers and heavy drinkers and that these lower death rates were very unlikely to be explained by chance variation alone. (c) One possible lurking variable is exercise. Perhaps light-to-moderate drinkers exercised more often than both nondrinkers and heavy drinkers. Regular exercise might be associated with lower risk of heart disease. In that case, we wouldn't know whether the light-to-moderate drinking or the regular exercise led to reduced risk of death from heart disease.

II.4 (a) There are two factors—storage of potatoes and cooking procedure. There are three levels for potato storage: fresh picked (i.e., not stored), stored for a month at room temperature, stored for a month refrigerated. There are two levels for cooking the potatoes: cooked immediately after slicing, sliced and cooked after an hour at room temperature. There are six treatments:

		Potato storage	
Cooking procedure	Fresh picked	Stored (room temp.)	Stored (refrigerated)
Cooked immediately	1	2	3
Cooked after an hour	4	5	6

The response variables are color and flavor of the french fries. (b) Potatoes will be randomly assigned in equal quantities to each of the six treatments (listed above). Each taster rates the color and flavor of the french fries from each treatment. The ratings are then compared to find the best storage method and cooking procedure. (c) The french fries should be served to the tasters on unmarked plates. Each taster will be presented with the six plates in random order. Between tastings, each taster should have some water, as a “wash out” process.

II.5 (a) Each customer will taste both the “Mocha Frappuccino Light” and the regular version of this coffee. The order in which the customer tastes the two products will be randomized. Between tastings, each customer will drink water for a “wash out” period. We can make this study double-blind if the customers are given the two types of coffee in unmarked cups. This way neither the customers nor the people serving the coffee know which type of coffee is in which cup. (b) We label each customer using labels 01, 02, 03, ..., 40. We enter the partial table of random digits and read two-digit groups. The labels 00 and 41 to 99 are not used in this example, so we ignore them. We also ignore any repeats of a label, since that customer has already been assigned to a group. The first 20 customers selected will receive “Mocha Frappuccino Light” first. The remaining 20 customers will receive the regular version first. Here, we pick only the first 3 in the “Mocha Frappuccino Light” first group. The first two-digit group is 07, so the customer with label 07 is in the “Mocha Frappuccino Light” first group. The second two-digit group is 51, which we ignore. The third two-digit group is 18, so the customer with label 18 is in the “Mocha Frappuccino Light” first group. The fourth two-digit group is 89, which we ignore. The fifth two-digit group is 15, so the customer with label 15 is in the “Mocha Frappuccino Light” first group. Thus, the first three customers in the “Mocha Frappuccino Light” first group are those customers with labels 07, 18, and 15. (c) No. Using a matched pairs design gives us an advantage over the completely randomized design. The advantage is that we can *compare* how each customer rates the new and regular coffee. Since each customer tastes both types of coffee, we can say which one the customer prefers and then look at the proportion of these customers who prefer the new coffee drink. A completely randomized design would not take advantage of this natural comparison due to pairing.

II.6 (a) One sampling method that depends on voluntary response would be to put an advertisement in the school paper and ask students who park on campus to complete a survey. Only those students who are passionate about the parking issue will respond to the survey, resulting in voluntary response bias. (b) One sampling method that is bad in another way would be to talk to students as they leave the parking lot. (c) A sampling method that would have more reliable results would be to select a random sample of students who park on campus and contact these students (probably via email) to find out their opinions about parking on campus. While we might still have some nonresponse, this sampling method attempts to eliminate bad sampling practices.

II.7 (a) “Controlled scientific studies” implies that controlled, randomized experiments have been used. The control part is important, because this means that the nonphysical treatments were *compared* to other treatments for the same ailments. The scientific part is what implies to the reader that this was an experiment, where the researchers randomly assigned subjects to treatment groups, instead of an observational study, where subjects self-select the treatments they

receive. (b) The control group allows for a comparison, while random assignment into treatment groups attempts to balance the unknown impacts of variables not under study.

II.8 (a) Randomly assign 36 of the acacia trees to have active beehives placed in them (the other 36 acacia trees will have empty beehives placed in them). Compare the damage caused by elephants to the trees with active and empty bee hives. (b) The randomization in this experiment is important so that variables such as location, accessibility, rainfall, etc. are “scattered” among the two groups (trees with active and empty beehives). (c) We would want the evaluators of the elephant behavior to be blind to which trees have active beehives and which trees have empty beehives, if possible, so that they do not knowingly or unknowingly rate the elephant damage differently based on this knowledge.

II.9 (a) In observational studies, the subjects “self-select” into the groups being observed. In experiments, the subjects are randomly assigned to treatment groups. We can show cause and effect with experiments, but not with observational studies. (b) A “randomized controlled trial” is one where subjects are randomized into treatment groups and a control group receiving an alternative treatment (possibly a placebo or dummy treatment) is used so that treatment effectiveness can be compared. (c) “Healthy user bias” means that the people who supplement with vitamin E might also do other things that contribute to their general health that might lessen the risk of heart disease. In an observational study, we cannot separate out this “healthy user bias” from the effect of vitamin E on the risk of heart disease. But, in a randomized controlled experiment, the randomization spreads the “healthy user bias” out among the treatment groups so it is not a factor we must consider.

II.10 (a) There will be 8 treatment groups, with 25 people randomized into each treatment group. The treatments are:

Treatment 1: 25% of food on sale, 60% off

Treatment 2: 50% of food on sale, 60% off

Treatment 3: 75% of food on sale, 60% off

Treatment 4: 100% of food on sale, 60% off

Treatment 5: 25% of food on sale, 50-70% off

Treatment 6: 50% of food on sale, 50-70% off

Treatment 7: 75% of food on sale, 50-70% off

Treatment 8: 100% of food on sale, 50-70% off

Researchers will compare the mean attractiveness rating given by individuals in the eight groups.

(b) Since there are 200 subjects, we label the subjects 001, 002, ..., 200. The labels 000 and 201 to 999 are not used in this example, so we ignore them. We also ignore any repeats of a label, since that subject is already in a treatment group. Once we have 25 subjects for the first treatment, we select 25 subjects for the second treatment, and so on, until all subjects have been assigned to a treatment group. Here we pick only the first 3 subjects. The first three-digit group is 457, which we ignore. The second three-digit group is 404, which we ignore. The third three-digit group is 180, so subject 180 is the first person assigned to treatment group 1. The fourth three-digit group is 765, which we ignore. We also ignore 561 and 333 until we get to 020, which means subject 020 is in treatment group 1. We then ignore 705 and assign the subject with label 193 to treatment group 1. (c) The range “50% to 70% off” slowly decreases in attractiveness to customers as the percent of goods on sale increases. To the contrary, the precise

“60% off” grows increasingly attractive to customers as the percent of goods on sale increases. When only 25% of food is on sale, customers rate the “50% to 70% off” range as more attractive than the precise “60% off” advertisement. For all other percents of foods on sale, the precise “60% off” is more attractive to customers and becomes more and more attractive than the range “50% to 70% off” as the percent of food items on sale increases.