Unit 15: Designing Experiments

PREREQUISITES

Unit 14, The Question of Causation, demonstrates the difficulty of establishing a cause-and-effect relationship between an explanatory variable and a response variable when an experiment is not possible. Therefore, Unit 14 provides a good motivation for this unit. Units 15 through 17 form a sequence on statistical methods for producing data. This unit has no statistical or mathematical prerequisites beyond basic arithmetic.

The video also would be appropriate to show to science classes (especially biology classes because of the choice of examples) as well as to mathematics and statistics classes.

ACTIVITY DESCRIPTION

In the activity, students are asked to collect news items that describe medical experiments. Such items appear quite often in newspapers and magazines. Have the class discuss what information appears in the articles about the design of the experiment. Comparison (treatment and control groups) will often be mentioned, but the fact that the subjects were assigned at random will often not appear. Some news items may contain observational studies as well – more grist for discussion.

THE VIDEO SOLUTIONS

1. The study did not impose human populations on the various coral reefs. Instead, scientists simply observed the health of the coral reefs in four areas where human interaction with the areas was varied from no humans living in the area to a sizable population of humans currently living in the area.

2. The subjects were patients suffering with osteoarthritis of the knee. Researchers wanted to compare the effects on joint pain of the dietary supplements of Glucosamine or Chondroitin compared to a prescription medication or a placebo.

3. Randomization produces groups of subjects that should be similar in all respects before the treatments are applied. It allows us to equalize the effect from unknown or uncontrollable sources of variation.

4. Sample answer: His sample size was extremely small (the last two he called 7 and 8, so there were 8 subjects total). He treated the two subjects differently – one was allowed to sit and the other had to stand for over an hour. This difference in treatment would certainly affect subjects' moods. He didn't randomly assign the medications. He interacted with the patients sympathizing with their responses. He didn't record exactly what one of his patients said and instead recorded only the higher ranking of mood.

UNIT ACTIVITY SOLUTIONS

Sample answer: A portion of a news article appears below.

Study: Mediterranean diet may not protect aging brain
MNS News, January 25, 2013
Andrew Seaman of Reuters

http://news.msn.com/science-technology/study-mediterranean-diet-may-not-protect-aging-brain

Hopes that a Mediterranean diet would be as good for the head as it is for the heart may have been dampened by a French study that found little benefit for aging brains from the diet rich in fruit, vegetables, whole grains, nuts, wine and olive oil.

The study, published in the *American Journal of Clinical Nutrition*, looked at the participants' dietary patterns in middle age and measured their cognitive performance at around age 65, but found no connection between Mediterranean eating and mental performance.

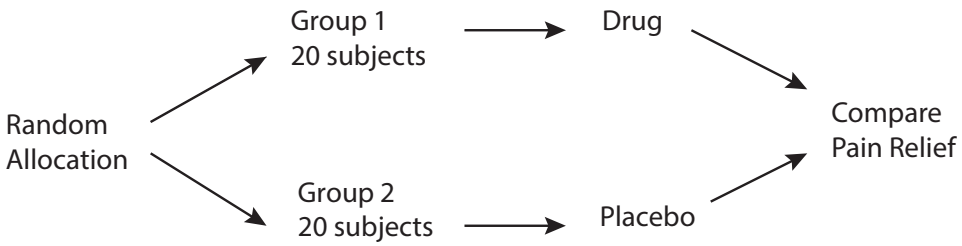
The study looked at patients' dietary patterns in middle age. Hence, this appears to be an observational study. There is no mention that a particular diet was imposed on the participants. The response variable is cognitive performance at age 65.

EXERCISE SOLUTIONS

1. No, this is not an experiment. The political scientist just gathers information from the subjects without imposing any treatment that could change their behavior. This is an observational study.

2. Yes, this is an experiment. The tasters are asked to react to specific treatments imposed on them by the experimenter, in this case to eat and compare the taste of two muffins.

3. a. The design is best outlined by a diagram. Students should give the size of the two groups (there are several reasons to use equal-sized groups in most cases), and to specify the treatments and the specific response they will look for.



b. Sample answers:

Using Table B from *The Basic Practice of Statistics*

Label the 40 subjects 01 to 40 in alphabetical order. Reading line 131 (this is a bit tedious) we get the 20 subjects in the drug group to be those with the following labels:

05	32	19	04	25	29	20	16	37	39
31	18	07	13	33	02	36	23	27	35

Subjects' names have been bolded in the table below.

01 Abrams	09 Daniels	17 Halsey	**25 Lippman**	**33 Rosen**
02 Adamson	10 Durr	**18 Howard**	26 Martinez	34 Solomon
03 Afifi	11 Edwards	**19 Hwang**	**27 McNeill**	**35 Thompson**
04 Brown	12 Fluharty	**20 Iselin**	28 Morse	**36 Travers**
05 Cansico	**13 Garcia**	21 Janle	**29 Ng**	**37 Turner**
06 Chen	14 Gerson	22 Kaplan	30 Obramowitz	38 Ullman
07 Cranston	15 Green	**23 Krushchev**	**31 Rivera**	**39 Williams**
08 Curzakis	**16 Gutierrez**	24 Lattimore	**32 Roberts**	40 Wong

Using Excel's random number generator Rand()

The names were entered into a column. In a second column 40 random numbers were generated. Then the names were sorted by the value of their associated random number. The bolded names in the table will be selected to receive the drug. The remaining 20 subjects will receive the placebo.

Janle	**Afifi**	**Travers**	**Kaplan**	**Roberts**	**Solomon**
Abrams	**Daniels**	**McNeil**	**Cansico**	**Rivera**	**Obramowitz**
Ng	**Durr**	**Garcia**	**Brown**	**Gutierrez**	**Lattimore**
Turner	**Curzakis**	Morse	Ullmann	Thompson	Krushchev
Hwang	Gerson	Adamson	Cranston	Edwards	Iselin
Williams	Lippman	Martinez	Howard	Fluharty	Chen
Rosen	Halsey	Green	Wong		

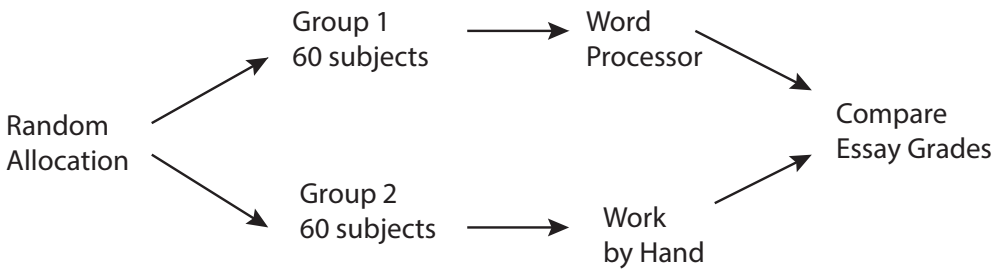
4. a. This is a double-blind experiment. Neither Dr. Colman, who is conducting the experiment, nor his patients know whether they are getting the remedy or the placebo.

b. In this case, both the person who conducted the experiment and the participants know which type of soda they are drinking. So this is not an example of either a single-blind or a double-blind experiment.

c. Since Janet labeled the cakes, she knows which is which. Her friends do not know which cake is made using cocoa and which using baking chocolate. Hence, this is a single-blind experiment.

REVIEW QUESTIONS SOLUTIONS

1. a. The response variable is not given explicitly, so students must specify what response they will measure. The grade on the essay is a reasonable choice, but there may be other good choices. Here is the outline of the design.



b. Sample answer: The essays should be read and graded by the same person (or two people – and scores averaged). More importantly, the experiment should be double-blind: the person reading the essays must not know which were word-processed. This means that all essays have to be retyped in the same form before being graded, so that only the quality of the essay influences the grade.

2. Sample answer: This is a very poorly designed experiment. First, it involved only two classes, which were at different schools and taught by different teachers (one more experienced than the other). The treatments, using the animated lessons compared to using handouts/ discussions, were not randomly assigned. Instead, only one of the two schools had sufficient numbers of computers to allow implementation of the animated science curriculum. Miss Earls' school was probably in a more affluent area than Mrs. Morrow's school – this conclusion is based on students' access to computers and the lower class size. So we don't even know if students in the two classes were similar in terms of their academic preparedness. Furthermore, Miss Earls designed the test, which may be biased toward the animated science lessons.

Miss Earls' school should not have purchased the animation science curriculum based solely on the outcome of this experiment.

3. a. This is an observational study – a prospective study. It takes a group of people, both smokers and nonsmokers, and observes them over a nine-year period. The response variable is whether or not the subject gets diabetes. The purpose of the study is to describe the

response variable (diabetic/not diabetic) for those who were smokers versus nonsmokers at the start of the study as well as those who were smokers and later quit smoking.

Background: In the article “Smoking, Smoking Cessation, and Risk for Type 2 Diabetes Mellitus” the design of the study was listed as a prospective cohort study.

b. You cannot conclude that quitting smoking causes diabetes. Most people who quit smoking also gain weight. Weight increases are also associated with diabetes. So, it would be impossible to tell whether the diabetes was caused by the cessation of smoking or the weight gain.

4. Sample answer: Randomly select the stores that consumer pairs will enter. Consumers should dress similarly – casual clothes suitable for visiting a mall (not too shabby but not too upscale either). The consumer pairs should be randomly assigned. Each pair should be randomly assigned to a store, complete their task and then be randomly assigned to the next store. There should be recorders with stopwatches to record the time it takes for a clerk to respond to a consumer pair.