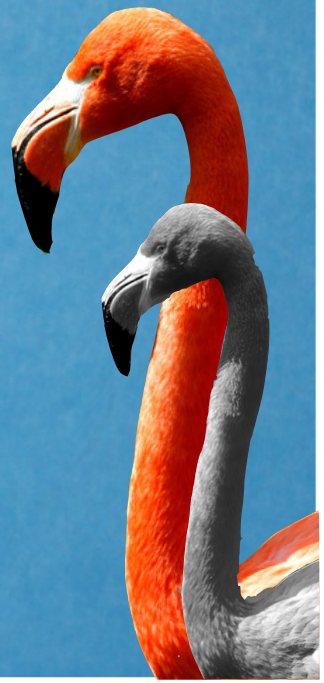
CHAPTER 4
Designing Studies

4.2c
Experiments



The Practice of Statistics, 5th Edition
Starnes, Tabor, Yates, Moore

Bedford Freeman Worth Publishers

Experiments

Learning Objectives

After this section, you should be able to:

- ✓ DISTINGUISH between an observational study and an experiment.
- ✓ EXPLAIN the concept of confounding.
- ✓ IDENTIFY the experimental units, explanatory and response variables, and treatments in an experiment.
- ✓ EXPLAIN the purpose of comparison, random assignment, control, and replication in an experiment.
- ✓ DESCRIBE a completely randomized design for an experiment.
- ✓ DESCRIBE the placebo effect and the purpose of blinding in an experiment.
- ✓ INTERPRET the meaning of statistically significant in the context of an experiment.
- ✓ EXPLAIN the purpose of blocking in an experiment. DESCRIBE a randomized block design or a matched pairs design for an experiment.

Experiments: What Can Go Wrong?

The logic of a randomized comparative experiment depends on our ability to treat all the subjects the same in every way except for the actual treatments being compared.

Good experiments, therefore, require careful attention to details to ensure that all subjects really are treated identically.

The response to a dummy treatment is called the **placebo effect**.

all about expectations of subjects

Placebo Effect

In a study reported by the New York Times on March 5, 2008 ("More Expensive Placebos Bring More Relief"), researchers discovered that placebos have a stronger effect when they are perceived to be more expensive. The study had volunteers rate the pain of an electric shock before and after taking a new medication. However, half of the subjects were told the medication cost $2.50 per dose, while the other half were told the medication cost $0.10 per dose. In reality, both medications were placebos, and both had a strong effect. Of the "cheap" placebo users, 61% experienced pain relief, while 85% of the "expensive" placebo users experienced pain relief. The researchers suggested that people are accustomed to paying more for better medications, which may account for the difference in response. As with any placebo, it's all about the expectations of the subjects.

Caffeine/pulse rate experiment—double blind

In a **double-blind experiment**, neither the subjects nor those who interact with them and measure the response variable know which treatment a subject received.

- Subjects blind
  - Two colas must look and taste exactly the same
- Those who interact with them should be unaware which subjects are receiving which treatment
  - Have subjects take their own pulse
  - Ask another teacher to prepare the colas with labels A and B and then leave the room before anyone else gets there
  - After experiment is complete, teacher can come back and reveal which treatment is which

There is always someone who knows which are subjects are receiving which treatment, but as long as this person doesn't interact with the subjects or measure the response, the experiment can still be double-blind.

Inference for Experiments

In an experiment, researchers usually hope to see a difference in the responses so large that it is unlikely to happen just because of chance variation.

We can use the laws of probability, which describe chance behavior, to learn whether the treatment effects are larger than we would expect to see if only chance were operating.

If they are, we call them **statistically significant**.

An observed effect so large that it would rarely occur by chance is called **statistically significant**.

A statistically significant association in data from a well-designed experiment *does* imply causation.

Fish Oil – Simulation

To see if fish oil can help reduce blood pressure, 14 males with high blood pressure were recruited and randomly assigned to one of two treatments. The first treatment was a 4-week diet that included fish oil, and the second was a 4-week diet that included regular oil. At the end of 4 weeks, each volunteer's blood pressure was measured again and the reduction in diastolic blood pressure was recorded. The results of this study are shown below. Note that the negative value means that the subject's blood pressure *increased*.

Fish oil: 8 12 10 14 2 0 0 $\bar{x}_F = 6.57$

Regular oil: -6 0 1 2 -3 -4 2 $\bar{x}_R = -1.14$

$\bar{x}_F - \bar{x}_R = 7.71$

Is there convincing evidence that fish oil is better than regular oil in reducing diastolic blood pressure? In other words, is the difference in mean reduction statistically significant? To find out, let's see what would happen if we randomly assign 14 people in the experiment to the two groups many times, *assuming the two treatments have the same effect on blood pressure.*

Fish Oil - Simulation

1. Write each person's reduction in blood pressure on a separate but equally sized slip of paper. (We will use notecards.)
2. Shuffle the papers and deal two piles of 7 each. The first pile will represent the fish oil group and the second pile will represent the regular oil group. Calculate the mean decrease for each group and then find the simulated difference in means ($\bar{x}_F - \bar{x}_R$).
3. Repeat this process many times and make a class dotplot of the simulated differences. How often did we get a difference of 7.71 or more?

Statistical Significance

- No random assignment will create perfectly equivalent treatment groups at the beginning of an experiment—there will likely be differences in the response variable just by chance.

- Results are called statistically significant only if the difference in the response is bigger than what would be expected due to chance variation in the random assignment.

- We will learn a lot more about statistical significance in Ch 9-12.

Experiments

Section Summary

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