

that is sufficiently large, it is even more important to have a sample in which subjects have been chosen in some appropriate way, such as random selection.

Use a sample size that is large enough to let us see the true nature of any effects, and obtain the sample using an appropriate method, such as one based on randomness.

In the experiment designed to test the Salk vaccine, 200,745 children were given the actual Salk vaccine and 201,229 other children were given a placebo. Because the actual experiment used sufficiently large sample sizes, the researchers could observe the effectiveness of the vaccine.

Blinding is in effect when the subject doesn't know whether he or she is receiving a treatment or a placebo. Blinding enables us to determine whether the treatment effect is significantly different from a **placebo effect**, which occurs when an untreated subject reports an improvement in symptoms. (The reported improvement in the placebo group may be real or imagined.) Blinding minimizes the placebo effect or allows investigators to account for it. The polio experiment was **double-blind**, which means that blinding occurred at two levels: (1) The children being injected didn't know whether they were getting the Salk vaccine or a placebo, and (2) the doctors who gave the injections and evaluated the results did not know either. Codes were used so that the researchers could objectively evaluate the effectiveness of the Salk vaccine.

Controlling Effects of Variables Results of experiments are sometimes ruined because of *confounding*.

DEFINITION Confounding occurs in an experiment when the investigators are not able to distinguish among the effects of different factors.

Try to design the experiment in such a way that confounding does not occur.

Designs of Experiments See Figure 1-5(a), where confounding can occur when the treatment group of women shows strong positive results. Here the treatment group consists of women and the placebo group consists of men. Confounding has occurred because we cannot determine whether the treatment or the gender of the subjects caused the positive results. It is important to design experiments in such a way as to control and understand the effects of the variables (such as treatments). The Salk vaccine experiment in Example 3 illustrates one method for controlling the effect of the treatment variable: Use a *completely randomized experimental design*, whereby randomness is used to assign subjects to the treatment group and the placebo group. A completely randomized experimental design is one of the following methods that are used to control effects of variables.

Completely Randomized Experimental Design: Assign subjects to different treatment groups through a process of *random selection*, as illustrated in Example 3 and Figure 1-5(b).

Randomized Block Design: A **block** is a group of subjects that are similar, but blocks differ in ways that might affect the outcome of the experiment. Use the following procedure, as illustrated in Figure 1-5(c):

1. Form blocks (or groups) of subjects with similar characteristics.
2. Randomly assign treatments to the subjects within each block.

Survey Pitfalls

Surveys constitute a huge and growing business in the United States, but survey

results can be compromised by many factors. A growing number of people refuse to respond; the average response rate

is now about 22%, compared to 36% around the year 2000. A growing number of people are more difficult to reach because they use cell phones (no directories); about 15% of adults now have cell phones and no landlines, and they tend to be younger than average. There are obvious problems associated with surveys that ask respondents about drug use, theft, or sexual behavior, and a *social desirability bias* occurs when survey respondents are not honest because they don't want to be viewed negatively by the person conducting the interview.

