Figure 9.17. EXPERIMENTAL PLANS: Experimental Design

Program 12 in: *Against All Odds: Inside Statistics*

When you want to answer a specific question, you need data that speak to that question. *Anecdotal evidence* based on a few individual cases is rarely trustworthy. *Available data* collected for other purposes, such as Census data or Vital Statistics, are often helpful. But sometimes we need to produce data of our own. Data intended to answer specific questions are usually produced by sampling or experimenting.

Sampling selects part of a population of interest to represent the whole. *Experiments* are distinguished from observational studies by actually *doing* something to the subjects of the experiment. Program 11 pointed out that evidence for a direct effect of an explanatory variable on a response variable is best obtained from an experiment. The statistical principles used to design experiments are the topic of this program. The video illustrates the distinction between observational studies and experiments by looking at research on the behaviour of lobsters. Some studies carefully observe lobsters with*out* doing anything to them. An experiment *does* something, such as cut off the antennules to see if the lobster becomes disoriented.

In an experiment, one or more *treatments* are imposed on the experimental *units* or *subjects*. Each treatment is a combination of levels of the explanatory variables, which are often called *factors*. The experiments in this program have only *one* factor. The *design* of an experiment refers to the choice of treatments and the manner in which the experimental units or subjects are assigned to the treatments. The video discusses the Physicians' Health Study (see also Figure 9.18 of the Course Materials), an important medical experiment which showed that taking aspirin regularly can reduce heart attacks. The subjects were 22,000 physicians; the treatments were aspirin tablets or a placebo (a dummy medicine) taken regularly. In this experiment, the explanatory variable (factor) was the type of medicine taken. The most important response variable is whether or not the subject suffers a heart attack.

There are three basic principles of statistical design of experiments. The first is *control*, which in its simplest form says that an experiment should *compare* several treatments. Experiments should be comparative in order to avoid *confounding* of the treatments with other influences, such as environmental variables. The second principle is *randomization*. Random assignment of the experimental units or subjects to the treatments creates treatment groups that are similar (except for chance variation) before the treatments are applied. Randomization and comparison together prevent *bias*, or systematic favouritism, in experiments. You can carry out randomization by giving numerical labels to the experimental units and using a *table of random digits* to choose treatment groups. The third principle is *replication* of the treatments on many units. This reduces the role of chance variation and makes the experiment more sensitive to differences among the treatments.

In addition to the Physicians' Health Study, the video describes an experiment that compares three treatments of domestic violence offenders; arrest and hold, arrest and release after booking, and mediation without an arrest. This story shows how randomized comparative experiments can help develop effective social policy. Although it seems arbitrary to decide the fate of a violent person at random, experiments like this changed police procedures across the country by showing that arresting offenders *does* reduce future violence. Only a randomized comparative experiment can give such strong evidence.

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