Experimental Design

Suppose you want to design an experiment to study memory. What is your first step?

People often imagine the first step in any scientific discovery is made by manipulating test tubes or observing animals… but the first step in a *real* scientific investigation is to consult the library. Scientists must first find out what others have discovered before trying to take a new step. You'd feel pretty silly announcing the results of months or years of experiments only to find out it was all "old news".

One of the great strengths of scientific study is to build new ideas on the foundation of what is already known. For instance, in the 1970s scientists began using fruit flies to study memory, and they based their studies on long-term and short-term memory differences in human patients. They could build on this existing knowledge by studying the genetic differences between long-term and short-term memory. So their first step was to **build on what was already known.**

The next step was to **ask the right question.** The scientists looked at one aspect of memory: the effect of repetition on memory. And they looked in a simple model system: fruit flies. Fruit flies can learn better if they are "taught" many times instead of just once.

The scientists had to control the conditions of the experiments so that they would know what conditions were responsible for the results they saw. They had to choose what was to be changed in the experiments. For example, in some tests, the scientists would vary how many times the animals were taught before their memory was tested, in other experiments, the scientists would vary the time between teaching and testing the flies. These were the **variables**. In order to make certain that the differences in memory were caused by the variables they were changing, they needed to keep the variables unchanged for one group of animals – the **controls.**

Throughout, it was important to **observe carefully** and **record** what was observed. For example, they had to note how flies were trained and tested. They had to count the number of flies out of each test group who successfully learned the danger signal. And the scientists had to determine how long the memory lasted. Then they had to **analyze these data** to decide what the data told about how memory works. Finally, these observations had to be recorded and communicated in such a way that other researchers could **see if the results were repeatable.**

How do you make scientific knowledge reliable? Scientists are human and therefore are not automatically objective. What they think is subject to impressions based on prejudice or other emotions or on misunderstanding of existing knowledge. In order for scientific knowledge to be reliable, scientists must follow specific rules to assure that they work is an accurate description of the world. The steps described here are important in providing **evidence that is scientifically valid, evidence on which scientific explanations can be built.**

Be a scientific thinker! Keep these ideas in mind as you explore the scientific information on this website, in your newspaper, on TV, in your textbooks or in scientific journals. As you encounter new information in biology, ask yourself, "How do I know"?