

Research Methods

By Richard Hall, 1998

We can differentiate between two basic types of research in neuroscience, experimental and quasi experimental. **Experimental research** is characterized by a situation in which an experimenter "controls" or "manipulates" some hypothetical causal factor (which is referred to as the independent variable), and observes the effect on some type of resultant factor (called the dependent variable). A second fundamental characteristic of experimental research is that the experimenter randomly assigns participants to experimental groups. In neuroscience it is most common to use animals in this type of research, due to the nature of the manipulations, which often involve physical manipulation of the nervous system, which would be unethical with human subjects.

In **Quasi-experimental** research the researcher observes some phenomenon that has happened after-the-fact. The researcher studies some type of phenomenon, which she or he has not manipulated, and examines the relationship among two or more variables, for example, some type of brain damage and the behavioral consequences. In quasi-experimental research the researchers do not manipulate or control an independent variable, nor do they randomly assign participants to groups. In fact, in quasi-experimental research there are no strict independent or dependent variables, since it is not clear as to what actually led to what.

As you might suspect the experimental method is much stronger in a strict scientific sense, in that the researcher can be much more sure about the nature of the causality. He or she can be relatively sure that the variable that was manipulated is the causal factor and the dependent variable is the resultant factor. This stronger degree of control, and certainty of causality is referred to as **internal validity**. However, the quasi-experimental method has some advantages as well, in that the observations are often the result of "real world" phenomena that were not created artificially in a laboratory. This is especially true in neuroscience research in that, quasi-experimental research is much more likely to include human subjects, and the fact is that neuroscientists are most frequently attempting to make generalizations about human behavior. This stronger degree of certainty as to the generalizability of results to the "real world" is referred to as **external** or ecological **validity**. The fact is that these two type of research often go hand in hand, and the most powerful type of research conclusion is one that is supported by both experimental and quasi-experimental research.

As an example consider the often cited research "fact" that smoking causes lung cancer. This conclusion is based on research in humans in which a significant relationship has been found between smoking and lung cancer. However, this is quasi-experimental research in that the experimenter did not manipulate any independent variable, nor were participants assigned to smoking vs. non-smoking groups. One can not be sure if the smoking *caused* the cancer. And in fact the cancer may be due to other behaviors that may be common in smokers, such as lack of exercise, alcohol consumption, or poor diet. While these experiments are strong in external validity, due to the ability of the

researcher to generalize to the "real world", they are weak in internal validity in that the researcher can not be very sure about what actually caused the cancer.

On the other hand the conclusion that smoking leads to cancer becomes much more powerful when one considers research with non-human animals, such as rats, in which the experimenter manipulates the independent variable by randomly assigning rats to smoking and non-smoking groups, and exposes one group to tobacco smoke and not the other. In this case if those in the experimental group are found to have higher levels of cancer, the researcher can be much more sure that the cancer was due to the smoke since the rats had little choice in the matter. This is especially true if the two groups were treated equivalently in all other ways (e.g., diet and exercise). On the other hand, most researchers are interested in generalizing to human populations in which people smoke as a matter of free will. So in this case the research is strong in internal validity, since the researcher can draw strong causal conclusions, but it is weak in external validity since the researcher can not generalize well to the "real world". However, taken together, these two research paths converge to add strong support to the original assertion that smoking leads to cancer. (Figure 1 is an illustration of these example experiments, and their relationship to validity).

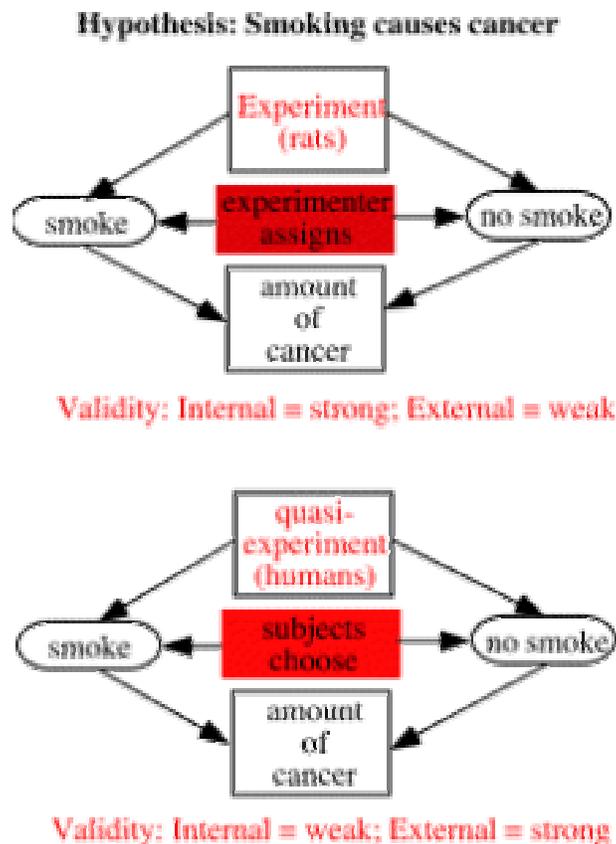


Figure 1. Smoking/Cancer Experiments and Validity

The example provided here is representative of much of the research that leads to the conclusions that neuroscientists presently make about the nature of the physiology and

behavior relationship. It is often the case that a human nervous system is altered through behaviors, accidents, or diseases, and that a corresponding abnormality in behavior is observed. This leads psychologists to form tentative hypothesis about the nature of the relationship between the areas of the nervous system effected and the corresponding behaviors. This is then studied, to whatever extent it can be, in animal experiments, and the original hypothesis is either supported, rejected, or modified.