PRINTED BY: holbrook@rowan.edu. Printing is for personal, private use only. No part of this book may be reproduced or transmitted without publisher's prior permission. Violators will be prosecuted.

Since we will be referring to hypotheses very often, we will use the letter H for "hypothesis," with a subscript to identify a specific hypothesis. Often, we'll simply use H_A to represent the alternate hypothesis and H_0 (subscript "zero") for the null hypothesis.

Activity

Come up with hypotheses to answer some of the questions you developed in the brainstorming in the previous section, or consider sample hypotheses provided by your instructor. Are they testable? Are they falsifiable?

Come up with null hypotheses for your hypotheses, or for hypotheses provided by your instructor.

1.3 Predictions

Presumably our hypothesis does a good job of explaining whatever we observed that caused us to ask a question; in other words, if it were true, our hypothesis would fully answer our question. We can make **predictions** based on that hypothesis regarding what else we might observe. Ideally, if those predictions don't match what we observe, we can reject our hypothesis. In the car example, we made a prediction about the functioning of the radio based on the hypothesis that a dead battery was preventing the car from starting; we also could have made a prediction that the radio would work based on the null hypothesis that the battery had nothing to do with why the car wouldn't start. In reality, data rarely fit a hypothesis perfectly, due to various sources of error, so what we do instead is compare how competing hypotheses fit our data and reject the hypothesis that has the worst fit. If we're only considering a single hypothesis, we can compare its predictions to those of the null hypothesis. When we do an experiment, we essentially attempt to manipulate conditions such that results predicted by the hypotheses being compared will be different.

For instance, consider the hypothesis that plants need sunlight to grow. The null hypothesis would be that sunlight has no effect on plant growth. We could then make predictions about how plants will grow with and without sunlight. According to our alternate hypothesis, plants would grow much better in sunlight than they would in darkness. Our null hypothesis would predict that plants will grow about the same regardless of whether they have sunlight or not. Thus, the alternate and null hypotheses predict that we will observe different things depending on which hypothesis is true.

Note that when we make predictions, we often need to specify exactly what the observations would be and how we would measure them. For instance, in our example above, we made predictions about growth based on each hypothesis. But what do we mean by "growth"? How would we know if one plant has "grown" more than another, and how could we represent this to another scientist? To solve this, we could take a measurement that we think describes growth. We could measure the height of a plant, or count its leaves, or weigh it. But "growth" refers to how much the plant has changed during the experiment,

PRINTED BY: holbrook@rowan.edu. Printing is for personal, private use only. No part of this book may be reproduced or transmitted without publisher's prior permission. Violators will be prosecuted.

so we could take the measurement at the beginning and the end of the experiment and determine the difference between the two; the value of the difference would be our measurement of growth. What we have constructed is a measurement to use as our **response variable**; in other words, this is the variable that we expect to have different values (i.e., to "respond" differently) in the experiment depending on whether the alternate or null hypothesis is true.

The response variable can also be called the **dependent variable**, because, at least according to the alternate hypothesis, its value should be dependent on another variable. In the case of the plant experiment, our dependent variable of growth is determined by the extent to which the plant is exposed to sunlight. The amount of sunlight would be our **independent variable**. You will often see graphs depicting the relationship between an independent and a dependent variable; the convention is for the *x* axis to represent the independent variable and the *y* axis to represent the dependent variable.

Activity

For each of the examples of hypotheses and related experiments provided below, do the following:

A) *Determine the null hypothesis.*

B) *Make predictions regarding the results of the experiment based on the alternate hypothesis and on the null hypothesis. What would the response variable(s) be for each experiment?*

C) *Make graphs representing your predicted results. What would go on the axes of your graphs? Which of the variables are the dependent and independent variables? You might not be able to specify the exact values predicted for the data for each hypothesis, but you should be able to depict how they would compare on the graph.*

Sample hypotheses with brief descriptions of experiments

1. *Acetylcholine stimulates muscle contraction.*

Cultures of muscle fibers are prepared. A solution of acetylcholine is applied to some of the cultures at different concentrations. Other cultures receive only the solvent without acetylcholine, and still others have nothing applied to them.

2. *Water moves from the roots of a plant upwards because of transpiration, where evaporation of water from leaves draws water up through the xylem.*

Plants are placed in a medium where their roots are submerged in water with a dye. Some plants have their stomata, tiny openings on the undersides of the leaves that allow for gas exchange, painted shut with nail polish. Other plants have some leaves painted, others not painted. Still other plants are not painted at all.

3. *Amphibian metamorphosis is regulated by the thyroid hormone thyroxin.*

Tadpoles are kept in a number of tanks. Some tanks have the thyroid hormone thyroxin added at different concentrations. Other tanks have no thyroxin added.