

## Chapter 1: The Scientific Method

### Reading Questions

1. The idea that the universe is controlled by a supernatural force or deity is best described as a(n): (a) empiricism, (b) cause and effect, **(c) teleology**, (d) scientific theory.
2. The first step in the scientific method is: (a) formulation of a hypothesis, **(b) observation of an event**, (c) setting up an experiment, (d) theorizing on the likely result.
3. Scientific reports of experiments are usually reported by the investigators in: (a) newspapers, (b) textbooks, **(c) scientific journals**, (d) magazines.
4. The basic assumption in science that all humans experience events in the same way through their senses is called: (a) uniformity in space and time, (b) natural causality, (c) cause and effect, **(d) common perception**.
5. A scientific statement that is based on experimental data and has some validity is known as a(n): **(a) conclusion**, (b) theory, (c) hypothesis, (d) explanation.
6. The condition or event that may change in an experiment is the: (a) independent variable, (b) controlled variable, (c) original observation, **(d) dependent variable**.
7. True or **False**: The results of an experiment do not have to be repeatable.
8. **True** or False: An experiment wherein the researcher cannot control all of the variables, common in animal behavior studies, is a natural experiment.
9. True or **False**: The variable that researchers try to keep the same for the experimental and control groups is the dependent variable.
10. True or **False**: Evolution is a popular hypothesis in biology, which needs further support to demonstrate its validity.

## In-Class Exercises

### Exercise 1

Some people claim that epileptic seizures are the result of a supernatural force being directed at a person for punishment of past behavior. Is this a statement of cause and effect or teleology?

Does it violate any of the assumptions above? If so, which one?

*Teleology, Yes, it violates natural causality.*

Others claim that epilepsy is the result of neurons misfiring in the brain of afflicted individuals.

Does this statement represent cause and effect or teleology? Does it violate any of the assumptions above? If so, which one?

*Cause and effect, No it does not violate any assumptions.*

### Exercise 2

An experiment is done to test the effect of a new experimental drug for high cholesterol. A group of 200 volunteers are separated into two groups of 100 each. Both groups are instructed to follow a similar diet and activity level. Group 1 is given the experimental drug daily for 90 days, while Group 2 is given a placebo. The individuals in the groups do not know whether they are taking the new drug or the placebo. All participants are tested at the start of the study for their serum cholesterol levels. The average for Group 1 is 310 mg/dl and the average for Group 2 is 302 mg/dl.

After 90 days, all participants' serum cholesterol is tested with a blood test. The average serum cholesterol level for Group 1 is 299mg/dl and the average for Group 2 is 300mg/dl.

Using this information answer the following:

- What is the hypothesis being tested? *The experimental drug will lower the cholesterol of individuals who have high cholesterol. (Hypotheses may be written differently, using an  $H_0$  and  $H_A$  scenario)*
- What is the dependent variable? *The serum cholesterol level*
- What are the independent variables? *The drug and placebo*
- Which variables are controlled? *Group size, diet and activities*

- e. Which is the control group? *Group 2 (given the placebo)*
- f. Did the experiment produce data that supports the hypothesis? *Not really. The mean values for Group 1 did decrease more than for the control group (Group 2), but not by much (cholesterol is still quite high).*

### Exercise 3

An experiment is done to test the effect of a high-fat diet on mice. In all, 50 weanling mice are separated at random into two groups of 25 each. At the start of the experiment all mice weight approximately the same amount, about 20 g. Group 1 is fed a normal diet with balanced amounts of protein, carbohydrates, vitamin supplements and fat. Group 2 is fed the same amount of protein, carbohydrates, and vitamin supplements, but given a much higher fat content. The cages are cleaned and mice are given fresh food and water daily.

After 6 months all mice are weighed. The average weight in grams for group 1 was 8.2g. The average weight for group 2 was 12.6g.

Using this information answer the following:

- a. What is the hypothesis being tested? *A diet high in fat will cause mice to gain more weight than one with a normal, balanced diet. (Hypotheses may be written differently, using an  $H_0$  and  $H_A$  scenario)*
- b. What is the dependent variable? *The weight of the mice*
- c. What are the independent variables? *The amount of fat in the diet*
- d. Which variables are controlled? *The amount of protein, carbohydrates, vitamin supplements and fat, how often the cages are cleaned, and how often the mice are given fresh food and water.*
- e. Which is the control group? *Group 1 (lower fat diet)*
- f. Did the experiment produce data that supports the hypothesis? *Yes, the average weight for Group 1 is much less than for Group 2. The Group 2 mice are heavier.*

### Exercise 4

An experiment is done to test the effect of artificial light on geraniums. Seventy-five geranium seedlings are grown in a laboratory. The plants are separated into five groups of 15 plants each. The following table shows the groups, how much light each receives per day, and

the average height of the plants after 180 days in the laboratory. All plants are fed the same amount of water and fertilizer daily. Group 4 receives as much light as all the other plants in the laboratory, which are not part of the experiment. Thus, 16 hours is average. Groups 1 and 3 receive less light than average, and Group 5 received more light than average.

| Group # | Hours of light per day | Height at 180 days |
|---------|------------------------|--------------------|
| 1       | 3                      | 5.0 cm             |
| 2       | 6                      | 14.5 cm            |
| 3       | 12                     | 29.2 cm            |
| 4       | 16                     | 36.1 cm            |
| 5       | 24                     | 25.4 cm            |

Using this information, answer the following:

- What is the hypothesis being tested? *The more light a geranium gets per day, the taller it will grow. (Hypotheses may be written differently, with an  $H_0$  and  $H_A$  scenario).*
- What is the dependent variable? *The height of the geraniums*
- What are the independent variables? *The amount of light per day*
- Which variables are controlled? *The amount of water and fertilizer (also group size, length of study)*
- Which is the control group? *Group 4 (with the average light per day)*
- Did the experiment produce data that supports the hypothesis? *Yes, up to 16 hours of light per day (the more light geraniums received, the taller they grew). But, when given 24 hours of light per day, growth was reduced.*

## Exercise 5

A series of observations that might be made by a biological anthropologist are listed at the end of this paragraph. Working in teams, choose one observation from the list, formulate a valid, testable hypothesis, and roughly design an experiment to test your hypothesis. In your work, state your hypothesis, dependent variable, independent variable, and control variable(s).

*\*The answers to this question can vary greatly. The hypotheses listed are just examples.\**

- Children from low income households show evidence of malnutrition.

*H<sub>0</sub>: Low income families cannot afford to purchase enough fruits and vegetables so their children are malnourished.*

- b. In most humans, the right humerus (upper arm bone) is larger than the left humerus.

*H<sub>0</sub>: The right humerus is larger in most humans due to most humans being right handed.*

- c. Expectant mothers who smoke often have low-birth-weight babies.

*H<sub>0</sub>: The chemicals in cigarette smoke will slow fetal growth.*

- d. People living on the island of Palau have the highest rates of schizophrenia in the world.

*H<sub>0</sub>: The betelnut that is chewed on the island causes schizophrenia.*

- e. Orangutans living in zoos tend to be overweight when compared to their wild counterparts.

*H<sub>0</sub>: Orangutans living in zoos do not exercise as much as those living in the wild and are fed a steady diet, causing them to be overweight compared to their wild counterparts who must forage for their food.*

## Exercise 6

- a. Review an article from a biological anthropology journal. Below list the titles and functions of the various sections.

*\*Answers may vary depending on journal article chosen\**

- For example, Abstract – summary of paper
- *Introduction* – what the study is going to do, background literature
- *Materials and Methods* – how the researcher(s) performed the experiment and what samples they used to do so
- *Results* – the results of the experiment, usually with lots of tables and graphs
- *Discussion* – what the results mean and how they fit within the existing knowledge of the subject
- *Conclusion* – A summing up of the data and how this information will be used and added to in the future

- b. In which section do you find the hypothesis being tested, or the study questions?

*Introduction*

c. Where would you look to find the details necessary to repeat this experiment?

*Materials and Methods*

## Post-Lab Questions

1. How does modern science differ from faith? How do these compare in terms of teleological or cause-and-effect explanations?

*Modern science is based on scientific methodology and the ability to test the possible answers to natural phenomena. Faith is based on belief without needing to “prove” or test such beliefs. Modern science relies upon cause and effect, while faith relies upon teleology*

2. Describe the three assumptions all sciences are based on.

*Natural Causality – All phenomena have a basis in nature or natural explanation*

*Uniformity in Space and Time – All phenomena will occur the same way regardless of the whenever or wherever it occurs*

*Common Perception – all individuals perceive events through their senses in the same way*

3. Describe the steps of the scientific method.

*Observation – A researcher observes a natural phenomena that is repeatable*

*Hypothesis – The researcher comes up with a reason why the natural phenomena occurs*

*Experiment - The researcher tests his/her hypothesis to see if it is accurate*

*Conclusion – The researcher sums up the experiment and determines if the hypothesis was accurate or not.*

4. What does an experiment test?

*The hypothesis*

5. Describe the difference between the:

- independent variable – *the variable that adjusted/manipulated to test the outcome*

- dependent variable - *the variable that is being tested, it may be affected by changing the independent variable*
- control variable – *Variables that are being held constant by the researcher*

6. Using Exercise 2, 3, or 4, can you identify any variables that were not controlled for in the study that could have been controlled?

*\*Answers will vary and may include: \**

*Exercise 2 – Amount of sleep, genetic predispositions, other medications and supplements...*

*Exercise 3 – Amount of exercise, amount of light...*

*Exercise 4 – size of the pot the plants are in, type of soil*

7. Reviewing your team's answers to Exercise 5, can you think of an alternate test of your hypothesis? Was anything left out of your original experiment?

*Student answers will vary.*

8. Choose a research article from a physical anthropology journal online or in the library. Can you identify what hypothesis the author(s) is/are testing? Is the experiment designed in such a way that it might be repeated by another investigator?

*Student answers will vary.*