ESS 200 (Stapleton) Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Practice Test: Experimental Design and Climate Change

**Answer Key**

Part 1: Designing experiments, Analyzing Data, Writing Lab Reports

Suppose you are trying to answer the question, “do dogs find hidden treats more quickly when there is silence or when *The* *Star Spangled Banner* is playing?”

On a separate sheet of paper, prepare a lab report for a fictitious investigation of this experimental question. Follow the same general guidelines that you followed for your slideshow project, but feel free to be more brief in this instance. Include the following in your lab report:

1. Write a hypothesis for this question. **Dogs will find treats more quickly when there is silence, because the music will distract them and prevent them from concentrating on smells.**

2. Identify the manipulated and responding variable. **Manipulated Variable: Sound (music or silence). Responding Variable: time to find treats.**

3. Write a procedure for testing your hypothesis.

 **Obtain one dog and use the same dog for all tests. For one week, feed the dog once per day at 1:00 PM. Find a square room with no significant air currents and divide the floor of the room into a grid. Before each trial, use a random number generator to select one of the grid squares. After one week of feeding the dog every day at 1 PM, perform an experiment at noon. At noon, place an extremely tasty dog treat in the center of a randomly-selected grid square and wait for one minute before guiding the dog to the doorway of the room. Immediately release the dog and do not allow it to leave the room. Start a timer when the dog is released, and do not respond to or communicate with the dog in any way until it finds the treat. Stop the timer at the moment the dog first touches the treat. At 1:00PM, feed the dog one bowl of food, and ensure that the dog does not eat before the next trial on the following day.**

 **Test the dog once each day. On even days of testing, conduct testing while playing the same version of The Star Spangled Banner from the same speaker, at a volume level of 5. Start the song 30 seconds before releasing the dog, and play it in a loop until the dog finds the treat. On odd days, conduct the testing in silence. All treats must be identical.**

**Notice variables that were controlled: the dog (exactly the same), practice (alternated music and silence), practice (treat location is random), motivation (equal hunger, equal treat), time of day, room, visual cues from human (no response to dog), starting location, time for smells to emanate from treat, wind (no air currents that might fluctuate).**

Imagine that you have conducted this experiment and that you have recorded the following data for the number of seconds it took for the dogs to find the treats:

Silence: 15, 14, 21, 27, 16, 19, 4, 25

Star Spangled Banner Playing: 13, 17, 16, 20, 24, 6, 7, 11

4. Create a useful table to display your data.

|  |  |
| --- | --- |
|  | **How long the dog took to find the treat (seconds)** |
| **Trials** | **Listening to Star Spangled Banner** | **Searching in Silence** |
| Day 1 | 13 | 15 |
| Day 2 | 17 | 14 |
| Day 3 | 16 | 21 |
| Day 4 | 20 | 27 |
| Day 5 | 24 | 16 |
| Day 6 | 6 | 19 |
| Day 7 | 7 | 4 |
| Day 8 | 11 | 25 |
| **Averages** | 14.3 | 17.6 |

5. Use a T-Test to analyze these data. Describe your statistical test and share the results of the test. [The screen shot above shows where you can find a link to the statistical test on the home page at www.mrstapleton.com.]

**I used a T-Test for dependent means (because my two test groups were the same dog). I had planned on using a one-tailed test, because I “chose sides” in my hypothesis. However, since it turned out that the dogs actually found treats faster with music playing, it was more appropriate to use a 2-tailed test. The p-value for that two-tailed test was 0.26.**

***If I had used a one-tailed test, my p-value would have been 0.13. If I had used a test for independent means (different dogs in each test group), my one-tailed p-value would have been 0.17, and the two-tailed p-value would have been 0.33).***

6. Write a conclusion for your experiment.

**My hypothesis was refuted by the results of this experiment. When a dog listened to the Star Spangled Banner, it was 3.3 seconds faster (on average) at finding treats (14.3 seconds, versus 17.6 seconds for silence). This is the opposite of what I expected. In addition, the P-value for this experiment was 0.26, which is above the significance cutoff of 0.05, so the results are not significant. There is no significant difference between the treat-finding speeds of dogs searching in silence and searching in when music is playing.**

Part 2: Scientific Method Matching: Match each of the terms below to a description that follows. Most of the descriptions match up with exactly one term, but **two of the descriptions will each be paired with two terms**.

Manipulated Variable Responding Variable Controlled Variable Dependent Variable Independent Variable Sample Size Hypothesis Results Conclusion Procedure P-value

Precision

7. **Precision:** the consistency of a measuring instrument

8. **Controlled Variable:** something that needs to be kept the same in an experiment

9. **Conclusion:** a statement, supported by citing data, about whether your hypothesis was supported or rejected.

10. **Sample Size:** a measure of how many times measurements were repeated (how many trials were conducted) in an experiment.

11. **Hypothesis:** an “educated guess” regarding the answer to an experimental question. This guess is made before the experiment is conducted.

12. **Results:** the data or observations recorded during an investigation

13. **Manipulated Variable (a.k.a. independent variable):** When your experiment involves a comparison of two groups, this is the one thing that should be different about the two groups.

14. **P-Value:** This could be loosely defined as a number that tells you the likelihood that the results of your experiment were due to random chance, assuming that there is no actual difference between your test groups.

15. **Responding Variable (a.k.a. dependent variable):** When you are trying to find out if there is a difference between two groups, this is what you measure when you test each group.

16. **Procedure:** This is a detailed account of all of the methods and steps that an investigator followed when he/she conducted an experiment.

Part 3: Climate Change Short Answer (from the climate change notes)

17. Why is it difficult to perform a valid scientific experiment to answer the question “is human activity contributing to global warming?” **In the case of global warming, it is difficult to control every variable except the manipulated and responding variables. An ideal way to test anthropogenic global warming would be to have at least two Earths; one that is identical to ours and another that would be identical in every way except that there would be no present or historical human activity. Unfortunately, that is impossible.**

**For #18-29, see climate notes for answers.**

18. Describe how climate scientists test whether or not a new climate model is valid, without waiting for years to see if the model has accurately predicted future climate change.

19. How do climate models support the assertion that humans are contributing to global warming?

20. What is the difference between *global warming* and *climate change*?

21. List the top 4 greenhouse gases, in order of impact, and describe at least one **important** source of each.

22. Explain how greenhouse gases contribute to global warming.

23. Describe two different ways in which deforestation can contribute to global warming.

24. Describe two natural causes of climate change.

25. Describe two different mechanisms for sea level rise resulting from global warming.

26. Describe two different positive feedback loops that can contribute to global warming, and briefly illustrate how they work.

27. Regarding the carbon cycle, describe identify two natural sources and two natural sinks of atmospheric carbon.

28. Some impacts of global warming are sea level rise and physical discomfort. List three other likely impacts of global warming.

29. Rank these storage banks of carbon from greatest (most carbon stored) to least:

 Atmosphere, Surface Ocean, Soil, Deep Ocean, Plant Biomass, Fossil Pool

 **1) Deep Ocean, 2) Fossil Pool, 3) Soil, 4) Ocean Surface, 5) Atmosphere, 6) Plant Biomass**