

AP Bio Lab Investigation #2: Investigating Environmental Changes on Pillbug Behavior



Objectives:

Upon completing this activity, you will be able to

- Create a representation that describes how organisms exchange information in response to internal changes and external cues, and which can result in changes in behavior.
- Analyze data that indicate how organisms exchange information with each other in response to internal changes and external cues, and which can change behavior.
- Describe how organisms exchange information with each other in response to internal changes or environmental cues.
- Engage in scientific questioning to guide investigations.
- Plan and implement data collection strategies in relation to a particular scientific question.
- Perform data analysis and evaluation of evidence.

Introduction

Ethology is the study of animal behavior. Behavior is an animal's response to sensory input and falls into two basic categories: **learned** and **innate** (inherited).

Orientation behaviors place the animal in its most favorable environment. In **taxis** the animal moves toward or away from a stimulus. Taxis is often exhibited when the stimulus is light, heat, moisture, sound or chemicals. **Kinesis** is a movement that is random and does not result in orientation with respect to a stimulus. If an organism responds to bright light by moving away, that is taxis. If an animal responds to bright light by moving in all directions, this is considered to be kinesis.

In the first part of this activity, you will learn to construct an ethogram, which is a data collecting tool used to gather information about typical behaviors an organism might exhibit. Next, you will make some general observations about the organism we will be working with—a common pillbug (*Armadillidium* sp.). You will then make notes about the pillbug's usual behaviors when it is placed into a choice chamber and record your observations using the ethogram you construct. A choice chamber is a chamber divided into two sections, with two different environments on either side.

For the second day of the experiment, you and your partner will design an experiment in which you choose one environmental variable to change in order to observe how the behavior of the pillbug changes once you have changed the environment. You will need to fill out an Experimental Design Map and get teacher approval before you will be allowed to conduct your self-designed experiment.

PART ONE: What is an Ethogram?

When we observe animals in an environment, we can keep track of the behaviors they engage in by constructing an **ethogram**. An ethogram is a data collection device used by behavioral scientists to record the instances of certain behaviors that are stereotypical of members of that species.

How is an Ethogram Constructed?

Categorizing behavior requires very close observation so that accurate ethograms of the species under study can be constructed.

There is no one right way to describe behavior. Two different ways to describe behavior are on the basis of structure and on the basis of consequences. **Structure descriptions** characterize the appearance or physical form of the behavior. In other words, the behavior is described in terms of the subject's posture, movements, and sounds. Think, for example, about how you might describe a handshake in terms of postures, movements, and sounds of two interacting people. Consequences are the presumed effects of the subject's behavior on itself, on its environment, or on other organisms. In **consequence description**, the behavior is described with respect to its presumed consequences without paying particular attention to the subject's posture, movements, and sounds. The handshake, which could be described above as postures and movements, could also be described as a "greeting ceremony" in a consequence description.

Categories such as "obtain food" or "escape predators" are descriptions in terms of their consequences. For example, "turn light on" is a consequence description, while "push switch down using index finger" is a description in terms of structure. Consequence description is the more economical of the two methods because it does not require the observer to make subtle discriminations between very complex movements. Subtle discriminations are important, but when first learning how to do ethograms, the structure description may be confusing. On the other hand, without structure descriptions, different workers may end up studying structurally different behaviors with similar consequences. For example, handshakes and "high fives" are both greetings involving the hands, but they occur in different contexts and are often used by different individuals.

A third type of description is **relational** and concerns the organism's spatial relations to other organisms or something in the environment. The focus is on *where* the organism is or with *who* it is, rather than *what* it is doing.

(From <http://www.animalbehavior.org/ABSEducation/laboratory-exercises-in-animal-behavior/laboratory-exercises-in-animal-behavior-ethograms>)

It is important to carefully consider stereotypical behaviors that your organism might engage in when constructing your ethogram. The behaviors you choose to look for should be general enough that all members of a species could engage in the behavior, but must be described specifically enough so that there is no ambiguity surrounding what the observed behavior is.

Here is a sample ethogram:

Type of Behavior	Behavior	Code	Description of Behavior
Solitary	Groom self	GS	Animal engages in washing or smoothing its own fur or hair using tongue or forelimbs
	Sleep	S	Animal assumes species-specific position for sleep, stays in one place and is not alert to environmental changes
	Rest	R	Animal stays in one place but may be roused easily by environmental changes
	Locomote	L	Animal moves from place to place
Food Related	Eat	E	Animal consumes food it finds in its environment
	Look for Food	LF	Animal searches the environment for food items
	Drink	D	Animal consumes water or other liquids found in its environment
Social	Groom Others	GO	Animal engages in washing or smoothing the fur or hair of another animal in its environment
	Play	P	Animal engages in interactions with others that may involve locomotion, climbing, manipulating objects or other activities that show a relationship between two or more interacting animals
Aggressive	Fight	F	Animal engages in physical conflict with another animal in its environment
	Steal Food	SF	Animal approaches another animal that has located food in the environment and either by physical force or distraction, removed that food item from the vicinity of the other animal

From <http://www.tolweb.org/onlinecontributors/app.jsessionid=02AF50480B967E62ACCD4A9277D84F93?page=TeacherResourceViewSupportMaterial&service=external&sp=3090&sp=4>


Note that the behaviors are general, but are described specifically enough so that there is no doubt as to what the behavior involves. Your ethogram for pillbug behavior should follow a similar structure but should detail behaviors that pillbugs would engage in.

For another example ethogram, look at: <http://gargoyle.arcadia.edu/biology/tamarin/Methods/Ethogram/ethogram.htm>

Why are Ethograms Used?

Ethograms are used to document a few things about an organism's behavior such as:

- How much time an organism engages in a certain behavior (and for how long each time).
- Patterns of behavior the organism exhibits.
- What behaviors allow the organism to survive, reproduce, or mate.

 You will now construct an ethogram that lists typical behaviors that you think pillbugs engage in their natural environment. You should list at least 8-10 behaviors, **in at least 3 different categories**. When you collect data, you will then make a tally sheet that chronicles how many of each behavior your pillbugs engage in during the 20 minutes of general observation you will do. You will transfer this ethogram to your lab notebook.

PART TWO: General Observation of Pillbug Behaviors and Investigating Effect of Changes to the Pillbug Environment

This portion of the investigation will have three parts:

Part A: you will make general observations about the pillbugs' behavior and use an ethogram to help you record qualitative data about their behavior.

Part B: You will predict which side of a choice chamber pillbugs will move toward: wet or dry. Then you will manipulate the pillbugs' environment by exposing them to a wet or dry environment in a choice chamber.

Part C: You will conduct an investigation about pillbug behavior based on your own experimental design which has been approved by your instructor.

SAFETY CONSIDERATION:

You will be working with **live** invertebrate organisms in this activity. It is important that you take precautions not to intentionally hurt or kill the organisms you are working with. Be sure to wash your hands after you complete the activity.

MATERIALS NEEDED:

Pillbugs (<i>Armadillidium vulgare</i>)	Choice chambers	Filter paper
File folders (to cut covers out of)	Water	Pipets
Spoons (for retrieving pillbugs from stock culture)	Timer	Other materials may be available as indicated by your instructor (for Part C)

Part A Procedure: General Observations

1. **Before beginning**, read through the directions to determine what sort of data chart you should create to gather data with.
2. Place 20 of the organisms in the choice chamber provided for you.
3. Observe the organisms for **20 full minutes**. A bit of patience is required here. It is also important that you focus and pay close attention to the behavior of your pillbugs—you don't want to miss anything!
4. Make careful and thorough notes on their general appearance, movements about the tray, and interactions with each other. **Make sure your observation of their behavior occurs each minute during this 20 minute period.** Notice if they appear to prefer one area to another, if they keep moving, settle down or move sporadically. Note any behaviors that involve 2 or more organisms. Try to make your observations *without* disturbing the organisms in any way. **Do not prod or poke or shake the tray, make loud sounds, or subject them to bright lights. You want to observe their behavior, not influence it or interfere with it.**
5. When you are done making your general observations, then move on to the second part of the experiment.

Part B Procedure: Changing the Environment—Wet and Dry

1. **Before beginning**, read through the directions to determine what sort of data chart you should create to gather data with.
2. **Before beginning** the experiment, make a prediction about which side of a choice chamber you think the pillbugs will move toward: the wet or the dry side. Be sure you **predict how many** will move toward each side in 20 minutes.
3. Using a pipet, thoroughly wet a piece of filter paper and place it in one section of a three-section choice chamber. Your teacher will demonstrate which section of the chamber you should use. Leave the other two sections dry.
4. Place 20 pillbugs into one of the dry sections and begin timing your 20 minute observation period. **Be sure you observe the organisms for 20 full minutes.** Record the number of pillbugs on either side of the choice chamber each minute for 20 minutes.
5. After you have completed your observations, carefully return the organisms to the stock culture, taking care not to harm or damage any of them. Clean out your choice chambers and return them to the supply area.

Part C Procedure: Changing the Environment—Student Designed Inquiry

1. Choose a variable to test. You will have in-class time to select your variable and to design your experiment.
2. Once your experimental procedure has been approved and peer-reviewed, you may begin experimentation.
3. Place 20 pillbugs into a dry section and begin timing your 20 minute observation period. **Be sure you observe the organisms for 20 full minutes.** Record the number of pillbugs on either side of the choice chamber each minute for 20 minutes.
4. After you have completed your observations, carefully return the organisms to the stock culture, taking care not to harm or damage any of them. Clean out your choice chambers and return them to the supply area.

DATA PRESENTATION, CONCLUSION AND ANALYSIS

Part A: You will turn in your data chart, an ethogram, and a time budget for this activity. Using your lab report rubric, you will need to construct appropriate graphs for the data you collected.

Part B: You will turn in your data charts and observations. You will also conduct a chi-square test to determine if your predicted numbers of pillbugs “fits” your observed number of pillbugs on each side of the choice chamber. We will learn how to conduct this statistical test in class, so don’t worry if you don’t know how to do it—I will teach you! 😊

**NOTE: PARTS A AND B WILL COUNT AS A LAB GRADE.
PART C WILL COUNT AS A TEST GRADE.**

Part C: You will write a full lab report for this section. Refer to your lab report grading rubric for guidelines that should be followed when writing this up.