Moth Mimicry: Using Ultrasound to Avoid Bats

hhmi | BioInteractive

Scientists at Work
Student Worksheet

OVERVIEW
This worksheet complements the short video "Moth Mimicry: Using Ultrasound to Avoid Bats" from the *Scientists at Work* series.

PROCEDURE
1. Prior to watching the film, read the questions below.
2. Watch the film.
3. If working with a partner or in a small group, discuss and answer the questions below. If working alone, think about and answer the questions below.

QUESTIONS
1. Insect-eating bats are nocturnal hunters that rely on echolocation. Study Figure 1 below.

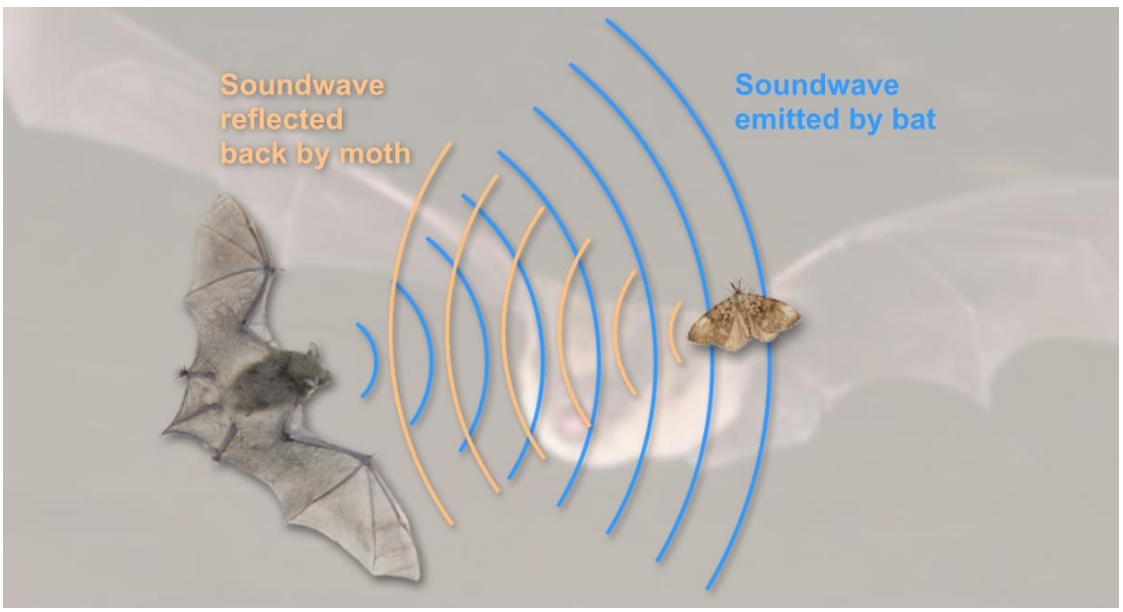

Figure 1. Bats produce high-frequency sound waves (ultrasounds) to locate potential prey. When they encounter an object, the soundwaves are reflected back. Bats detect and interpret the reflected sound waves to determine the size and location of the object.

a. Develop a prediction about how a bat determines whether an object is close or far away.

b. Develop a prediction about how a bat determines whether an object is large or small.

2. List two advantages of using sound rather than vision or smell to detect prey.

3. Of the nearly 140,000 moth species that exist, as many as half may be able to hear bat echolocation. When they hear the bat calls, some moths try to escape, while others produce ultrasounds in response. What are two ways in which ultrasound production can help moths avoid being eaten by bats?

4. In the video, which strategy did Dr. Barber say most moths in Gorongosa were using to escape bats? List two pieces of evidence from the film that support this claim.

5. a. Define **Batesian mimicry**.

   b. How are some sound-producing moths an example of Batesian mimicry?

6. Toward the end of the film, this statement appears in the video: "Coevolution: bats and moths reciprocally affect each other's evolution." Explain, in your own words, how each organism affects the other's evolution.

7. At the end of the film, Dr. Barber states, "This is the beauty of the scientific method – it's self-advancing. Each question opens up new questions. We'll never run out of questions about anything on this planet." If you joined the moth-bat research team in Gorongosa, what new scientific question would you like to try to answer? (Be sure to develop a question that is "testable" and able to be investigated by designing an experiment.)

8. Before coming to Gorongosa, Dr. Barber had studied anti-bat sound production by hawkmoths (family Sphingidae) in the lab. He designed an experiment similar to the one shown in the film, in which he exposed a big brown bat (*Eptesicus fuscus*) to falcon sphinx moths (*Xylophanes falco*) tethered at the end of a plastic rod for four consecutive nights; the experiment was repeated with a different bat over eight nights. Each night two sound-producing *X. falco* were randomly introduced to the bat, along with eight other silent moths: two *X. falco* moths with their sound-producing organs removed (ablated), two white lined sphinx moths (*Hyles lineata*), and four greater wax moths (*Galleria mellonella*), which are naturally silent.

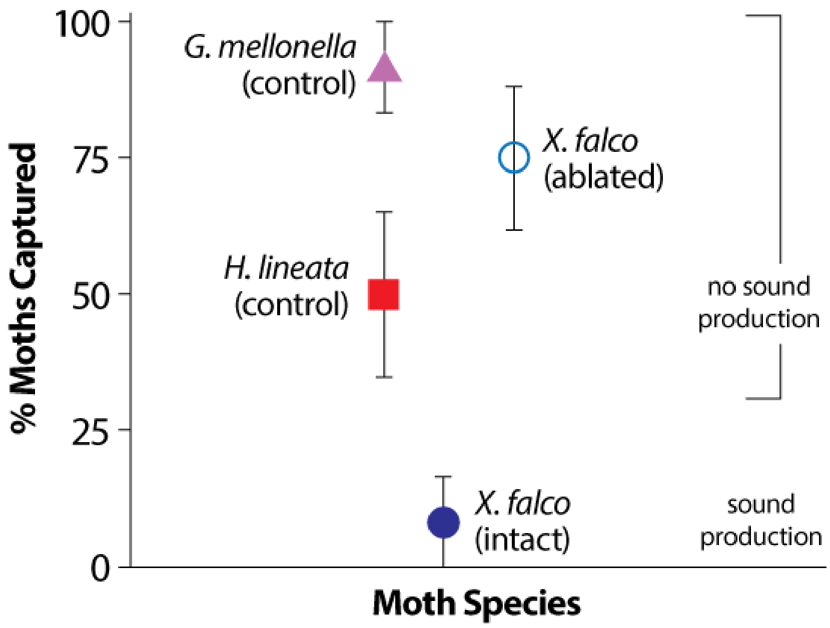

Figure 2. The proportion of moths caught by bats. The symbols correspond to the average percentage of moths captured over the course of the experiment and the error bars represent 95% confidence intervals. (Adapted from Akito Y. Kawahara and Jesse R. Barber. 2015. *Proceedings of the National Academy of Sciences*, 112:6407-6412.)

a. What is the dependent variable of the experiment? ________________________________

b. What is the independent variable? _____________________

c. Using the graphs, complete the table.

Moth Species	***X. falco intact***	***X. falco ablated***	***G. mellonella***	***H. lineata***
Percentage of Moths Captured				
Sound Production Yes/No				

d. Was ablated or intact *X. falco* more likely to be captured? Approximately how many times more likely? (Show your calculations.)

e. The *G. mellonella* and *H. lineata* moths are control moth species. Why is adding these controls important to this experiment? Why is it not enough to just compare *X. falco* intact and ablated?

f. When he published the results of this experiment, Dr. Barber noted that the probability of capture did not vary significantly between different nights. How do you interpret this finding?

g. In this experiment, Dr. Barber predicted that silent moths would be captured more frequently than ultrasound-producing moths. Do the data support this prediction? Use evidence from the data and graph to support your answer and explain why ultrasound production is a viable strategy to avoid predation.

h. *Optional statistics question*: The ablated and intact falcon sphinx moth data show 95% confidence intervals. What can be inferred by including confidence intervals when comparing the percentages of moths captured in this experiment? Justify your response with evidence.