STUDENT SHEET (LEVEL 2) - ANSWER KEY

Nature vs. Nurture: How Genes and the Environment Shape Vocal Learning in Songbirds

Name: ANSWER KEY Date: _____

Using songbirds as a model to understand the contributions of genetics and environment in vocal learning

Key concepts

- Traits are determined by genetics and environment.
- Genetics refers to the genes (pieces of DNA) that a living thing has and how they are activated.
- Environment refers to the surroundings and experiences that a living thing has during its life.
- Neuroplasticity (*neuro* means brain and *plasticity* means modable or changeable) is the idea that brains change as a living thing learns.

Part 1: Background Information

1. What are the three types of finches we will be using in our experiment? Describe each of their songs in your own words.

Type of Finch	Description of Song
Zebra Finch (ZF)	Varies
Long-Tailed Finch (LF)	Varies
Bengalese Finch (BF)	Varies

2. Why do male finches sing?

Male finches sing to attract mates.

3. Why are finches a good model organism for learning about how humans learn language?

Finches are one of the few animals that are capable of vocal learning. They are easy to care for and have simple songs.

4. What brain features do all vocal learners share?

They all have a circuit that connects the listening area of the brain to the motor area of the brain that controls the movements needed for speech/singing.

5. How are genetics important in forming this brain feature?

A group of 50-70 genes has been shown to be activated similarly in humans and finches. These genes, when activated, help build the circuit that makes vocal learning possible.

6. What role does neuroplasticity play in vocal learning?

Neuroplasticity means that the brain is changeable. The neurons of the vocal learning circuit change based on the songs that a finch hears as a baby. Like with humans, the brain physically changes as the bird learns from its environment.

Part 2: Experimental Design

Your task is to design an experiment that will provide evidence to help determine if a finch's song is determined by its **genes**, its **environment**, or **both**.

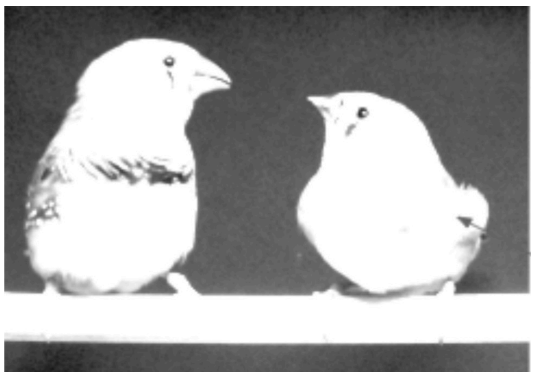
You will use two finches (experimental and control) that are twin brothers for this experiment - you can choose which species. Your control finch should be tutored by the same species that it normally would. For your experimental finch, you can change up the tutor.

You have the following available to you:

Baby Finches	Tutors
2 Zebra Finch Brothers	Zebra Finch (will only teach Zebra Finch)
2 Bengalese Finch Brothers	Bengalese Finch (will teach ANY finch)
2 Long-Tailed Finch Brothers	Long-Tailed Finch (will only teach Long-Tailed Finch)
	No Tutor

Fill in the blanks below to show your experimental design and your hypothesis/predictions.

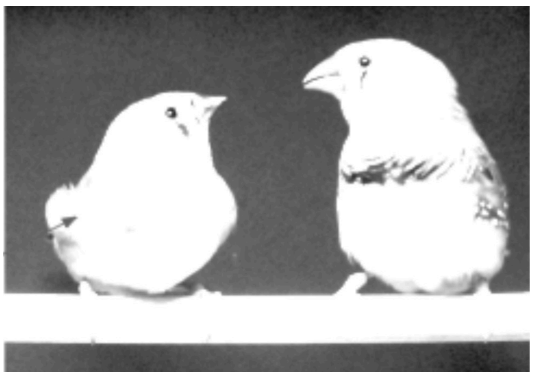
CONTROL TREATMENT



Baby Finch Species:

(student choice)

EXPERIMENTAL TREATMENT



Control Tutor Species:
(same species as baby)

Experimental Tutor Species:
(Bengalese or No Tutor)

Prediction: What do you think the baby's song will be like?

It should be the typical song for the baby and tutor species.

Prediction: What do you think the baby's song will be like?

It should be the song of the tutor species (Bengalese) or no song (if No Tutor).

Hypothesis: What is your reasoning for your predictions?

Though genetics is the basis of the vocal learning circuit, the baby should learn the song of the tutor as it listens and practices the song.

Part 3: Experimental Results

Use the following website to carry out your experiment: https://sites.google.com/view/finch-experiment/

SONGS

Listen to the audio clips of your control and experimental baby finches. Compare and contrast them to the clips of each adult species.

1. What do you learn from the song of your control baby finch?

   It sounds most like the typical song of its own species.

2. What do you learn from the song of your experimental baby finch?

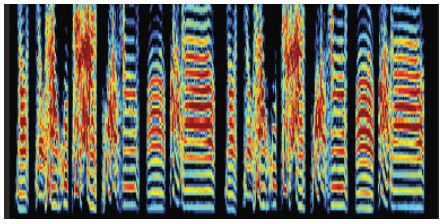
   If Bengalese: it sounds most like the typical song of the Bengalese Finch.
   If Isolate: it does not sound like any of the typical songs.

SPECTROGRAMS

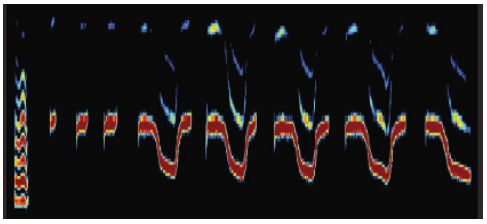
Sketch the spectrograms below for each baby finch and compare/contrast them to spectrograms for tutor and own species.

Control Baby Finch	Experimental Baby Finch
Sketch: Varies	Sketch: Varies
Comparison/Conclusion: It looks most like the spectrogram of its own species	Comparison/Conclusion: If Bengalese: it looks most like the Bengalese Finch If Isolate: it does not look like any of the spectrograms

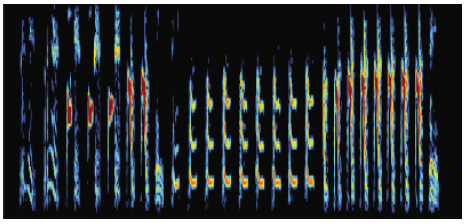
Zebra Finch



Long-Tailed Finch



Bengalese Finch



NEURON ACTIVITY

Describe the activity of the neurons (*normal* or *high*) in the deep and secondary parts of the listening area of the brain for each situation.

1. Control finch listening to the same species.

High

2. Control finch listening to other species.

Normal

3. Experimental finch listening to the same species.

Normal

4. Experimental finch listening to other species.

If Bengalese: high
If Isolate: normal

What conclusion can you make from the neuron activity that you observed?

Finches have higher neuron activity and pay closer attention when they hear the song of the tutor, even when the tutor is a different species.

Part 4: Assessment

Is finch song determined by genes, environment, or a combination of both?

Generate a claim to answer the research question, and support your claim using 3 pieces of evidence from the background material and your experimental results.

CLAIM:

Some students may say only environment, because the experiment data supports that claim, but when incorporating the background information, the best answer is:
Finch song is determined by a combination of genetics and environment.

Evidence will vary depending on experimental design, but here are a few possibilities:

POSSIBLE EVIDENCE
Humans and songbirds have a similar activation pattern in 50-70 genes that are associated with the vocal learning circuit.

REASONING
This fact from the background information shows that genetics are important to create the circuit that allows vocal learning to occur. These genes are not activated in the same way in animals that are not capable of vocal learning.

POSSIBLE EVIDENCE

Experimental Bird spectrogram is similar to tutor species.

REASONING

This shows that the genes of the bird do not determine what song it will sing as it learned the song of the tutor, even though it was a different species. Therefore, environment is important for vocal learning.

POSSIBLE EVIDENCE

Experimental Bird song is similar to tutor species.

REASONING

This shows that the genes of the bird do not determine what song it will sing as it learned the song of the tutor, even though it was a different species. Therefore, environment is important for vocal learning.

POSSIBLE EVIDENCE

Isolate bird spectrogram does not match any spectrogram.

REASONING

This shows that the genes of the bird do not determine what song it will sing as it did not develop a structured song. Therefore, environment is important for vocal learning.

POSSIBLE EVIDENCE

Isolate bird song does not match any song.

REASONING

This shows that the genes of the bird do not determine what song it will sing as it did not develop a structured song. Therefore, environment is important for vocal learning.

POSSIBLE EVIDENCE

Neuron activity in the secondary and deep parts of the listening area of the brain is higher when experimental finch hears the song of its tutor, even though the tutor is a different species.

REASONING

This shows that the experimental finch's brain has changed from the experience of listening to the tutor so that it is more sensitive to the song of the tutor species. Therefore, environment is important for vocal learning as it changes the listening area of the brain.