**Worksheet: How Zebra Finches Learn to Sing**

*You will not have to turn in this worksheet, so take notes in whatever manner is most helpful to you.*

Reference: Daniela Vallentin et al. (2016), “Inhibition protects acquired song segments during vocal learning in zebra finches,” *Science* **351**: 267-71.

Goals

* Apply general concepts (neural circuits, excitatory and inhibitory connections) to the specific neurophysiological problem of how zebra finches learn to sing.
* Understand Figure S10 (the overall summary of the study’s conclusions).
* Understand how the data in the other figures led to the conclusions in Figure S10.

Group roles to assign

* **Discussion leader:** introduces questions, allots time for solo work, gathers input
* **Lifeline:** looks things up, gets instructor’s attention
* **Equity officer:** ensures equal participation
* **Digression manager:** keeps discussion on track

General background

For background information, please see the study guide file posted to the Homework folder of Canvas’s Files page (2016\_03\_07\_Vallentin\_study\_guide.docx).

Questions

1. What is the overall research question that Vallentin et al. try to answer, at least partially, in this study? (The question should be a bit more specific than “How to birds learn to sing?”)

2. What previous research led Vallentin et al. to believe that the answer to their question would involve the HVC? Did the researchers look at any other parts of the brain besides the HVC?

3. Your homework for today asked you to summarize the overall message of Figure 1. Discuss this with your table-mates. What is the overall message, according to your group?

4. One key aspect of Figure 2 is the distinction between HVC interneurons and premotor neurons. How do these two types of neurons interact? (You may want to make a simple sketch.) Which parts of the figure go with which neurons, and what is being detected in each case (action potentials? inhibitory currents?).

5. The key question answered by Figure 2 is whether inhibition of HVC premotor neurons depends on age or on song-learning progress. What is the answer to this question? Which specific data support your answer?

After Figure 2, there is an interesting pivot point in the paper.

* First Vallentin et al. **summarize Figure 2**: “These results demonstrate that the maturation of sensory-evoked inhibition in HVC matches the bird’s learning progress rather than its developmental stage.”
* Then they pose an important **question**: “What function might this inhibition serve?”
* Then they offer a **hypothesis**: “We hypothesized that precisely timed inhibition in HVC could selectively target portions of the song that have been adequately learned, thereby suppressing the effect of sensory inputs on premotor neurons during those times and preventing further plasticity in motor output.”
* Finally, they make **two predictions** based on this hypothesis:
	+ “One prediction is that all premotor neurons should receive the inhibitory signal simultaneously, which would allow for robust suppression of sensory inputs on the entire premotor system.”
	+ “A second prediction is that the global inhibitory signal should vary in strength as a function of how well each segment of the song has been learned, with stronger inhibition associated with better-learned segments.”

6. Confirm your understanding of the above hypothesis and predictions with your table-mates.

7. Figure 3 addresses the first prediction. Are these data consistent with the prediction? Explain.

8. Figure 4 addresses the second prediction. First, confirm your understanding of panel A (the training procedure) with your table-mates. Then explain how panels B and C illustrate the second-to-last stage of panel A, and how panels D and E illustrate the last stage of panel A.

9. Panels B through E essentially show that it is possible to study juveniles at a stage where they have learned one part of a song (syllable A) but not another part (syllable B). Now the key question becomes, what do the inhibitory inputs look like at this stage? Specifically, are they consistent with the second prediction? Describe which specific data are consistent or inconsistent with the prediction.

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| 10. Here is Figure S10 again. Now that you have worked your way through Figures 1 through 4, list the specific data figure panels that support key aspects of Figure S10. |  |