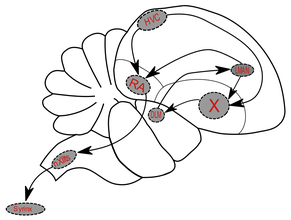
Morphological Characterization of Cortical Premotor Neurons of Juvenile Zebra Finches

James Fair; Research Mentor: Amanda Brunick
Program in Neuroscience

Background

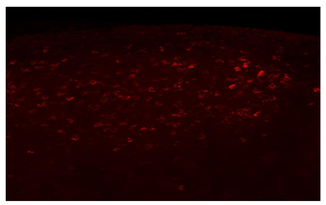
- Learned vocalizations require sufficient auditory exposure
- Zebra finches are songbirds that learn their song from their father, but only males sing

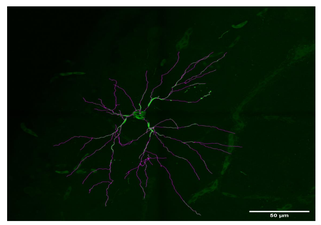


- A song control network controls this behavior and is sensitive to auditory experience during development
- HVC is a cortical premotor nucleus necessary for adult song production that is sensitive to auditory experience and projects to two motor pathways
- HVC is present in both males and females, though it is much smaller in females
- Both males and females undergo auditory learning during development, but what is the purpose of HVC in non-singing females?
- **We predict that the morphology of HVC neurons will differ between males and females and may partially explain why females don't sing beyond simply having a smaller HVC**

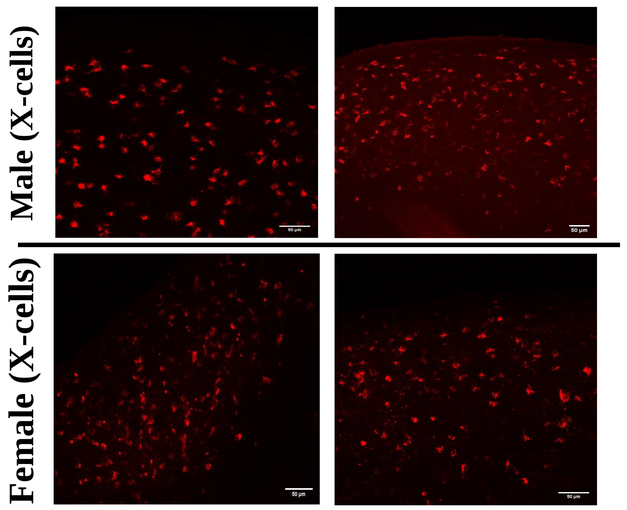
Methods

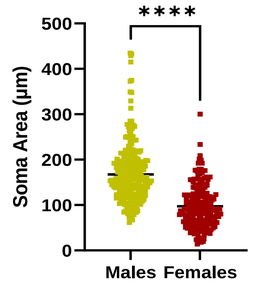
- HVC was backfilled with a fluorescent dye and individual neurons were filled with biocytin, fixed, and processed for confocal microscopy
- Three-dimensional z-stacked images of these cells and their neuronal arborizations were collected and later analyzed offline using ImageJ's simple neurite tracer (SNT)
- Cell arborizations were traced to generate partial reconstructions and a variety of morphological measurements were derived and compared between both individual cells and groups

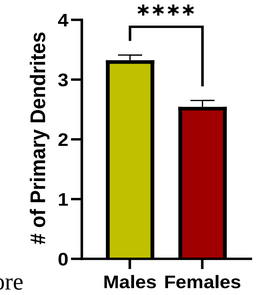




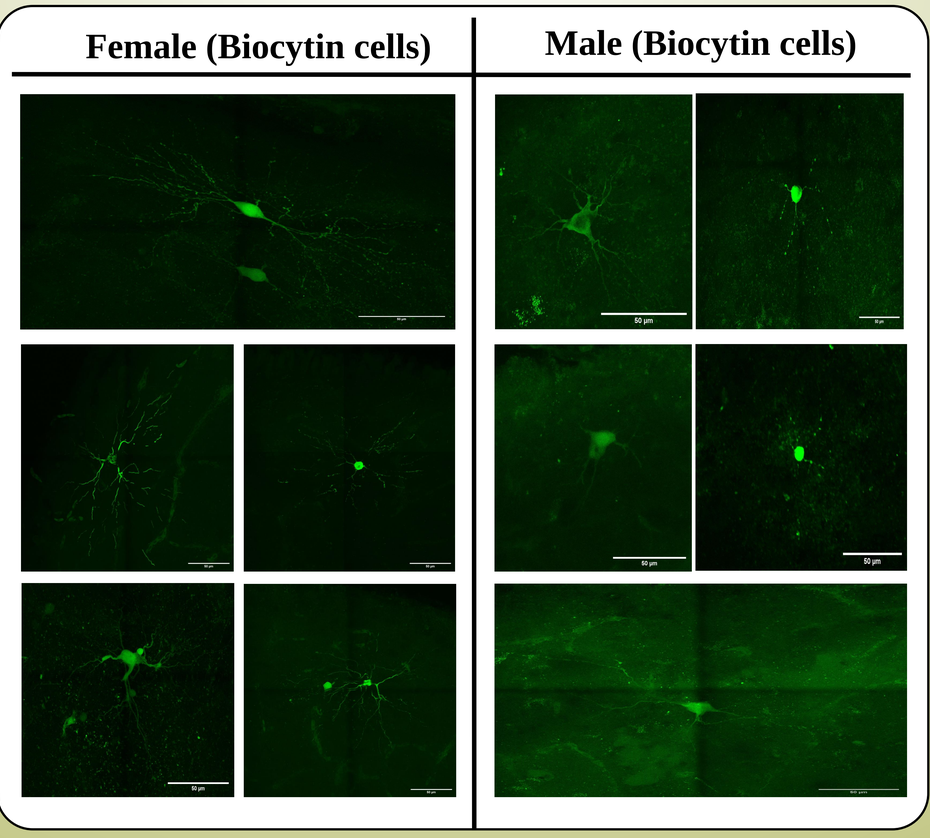
Results



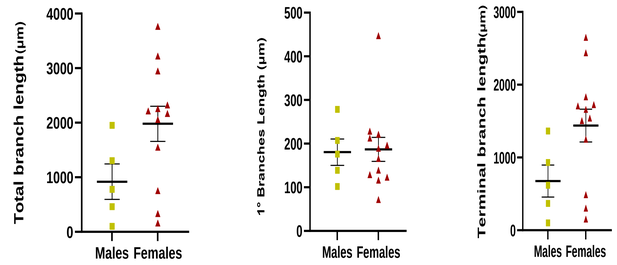




On average, male HVC_X neurons have larger somas and more primary dendrites than females



Results (cont.)



Comparison of a few morphological features suggests there are at least 3 subtypes of female HVC neurons
Arborizations of female neurons tend to cover more of HVC, though this seems to be specific to terminal branches

Conclusions

- Projection neurons from HVC to Area X exhibit larger somas and more primary dendrites in juvenile males than females
- The sample of individually-filled neurons from females have arborizations that cover more of HVC than those from males
- Additionally, there seems to be a few subtypes based on the direction of the arborizations:
  - Male cells project rostral-caudally & ventrally or equally in these directions
  - Females exhibit similar patterns to males but also have some cells that are limited to the rostral-caudal axis
- Both the extent of arborizations and their directions affect activity and information transfer within HVC
- Perhaps the morphological differences in female HVC may partially explain why they only produce calls and not song despite receiving the same auditory experience as the males

Acknowledgements/References

We thank Dr. Yuan Wang for technical assistance and guidance on imaging

Benezra, S. E., Narayanan, R. T., Egger, R., Oberlaender, M., & Long, M. A. (2018). Morphological characterization of HVC projection neurons in the zebra finch (Taeniopygia guttata). *The Journal of comparative neurology*, *526*(10), 1673–1689. https://doi.org/10.1002/cne.24437

Egger, R., Tupikov, Y., Elmaleh, M., Katlowitz, K. A., Benezra, S. E., Picardo, M. A., Moll, F., Kornfeld, J., Jin, D. Z., & Long, M. A. (2020). Local Axonal Conduction Shapes the Spatiotemporal Properties of Neural Sequences. *Cell*, *183*(2), 537–548.e12. https://doi.org/10.1016/j.cell.2020.09.019