Investigating Sensorimotor Circuits to Understand How the Brain Generates Different Sounds Used in Vocal Communication

ASHKIA CAMPBELL
ADVISOR DR. JONATHAN PRATHER
Why understand vocalization?

Auditory perception and vocal articulation are essential survival mechanisms used to navigate through a socially dependent society.
Why understand vocalization?

- To understand connections between perception and auditory output
- To find if neural mechanisms to produce vocalization are analogous between geographic and phylogenetically different species
- To start a basis for further human speech advancements

Bengalese Finch of Asia

Zebra Finch of Australia
Why use song birds?

- Difficult to complete experiments on humans

Why we use song birds:

- Limited vocal variety
- Can be tested across geographically separate species
- Brain processes anatomically analogous to the hominid brain
The Hominid vs Avian Brain
HVC in Avian Brain

HVC Microcircuit

Auditory input

HVC\textsubscript{x}

HVC\textsubscript{INT}

HVC\textsubscript{RA}

Anterior forebrain pathway

Song motor pathway
Hypothesis

Auditory perception and vocalization will be found analogous across species as the HVCRA neurons make excitatory connections directly onto HVCX neurons.
Methods

- 400 micron sagittal brain slices
- Bathe neural tissue in artificial CSF solution in humidifying chamber
- Pull glass electrodes – temp, pressure, pull time
  - Ionize silver electrode and insert into pulled electrode
  - Fill electrode ¼ full with artificial CSF
Methods

- Place tissue into recording chamber
- Align electrode to HVC cell of interest
- Ring electrode to penetrate cell
- Find second neuron and pulse for electrophysiological response
- Record electrophysiological response to stimuli
  - Inhibitory/Excitatory
Results

Zebra and Bengalese Finches both use pathways to allow for HVCRA neurons to make excitatory connections directly onto HVCX neurons.
Results

Zebra and Bengalese Finches both use the pathways to allow for HVCRA neurons to make excitatory connections directly onto HVCX neurons.
Conclusion and Further Research

Zebra and Bengalese Finches both use the same excitatory pathways of HVC.
- Pathways are analogous between geographically different species.
- The same mechanisms are used across different phylogenies.

Further Research
- Repeat experiments on another geographically separate species from N. America
- Continue to study species with increased complexity of vocal repertoires
- Eventually, begin using analogous process to understand and possibly alleviate speech impediments such as stuttering.
Thank you

- The Prather Lab
- Dr. Jonathan Prather for guidance throughout this project.