Bacilio B. Benelalija
Undergraduate
Tulane University, New Orleans, LA, 70118

Mentor: XiaoChing Li, Ph.D.:
Louisiana State University Health Sciences Center, Neuroscience Center of Excellence

"Identifying Expression Patterns of Genes MeCP2 and FOXG1 in the Zebra Finch Songbird Neural Song Network"

It has been established that young humans develop speech and language skills in incremental stages by imitating adults. In a similar manner, young zebra finch songbirds learn to sing and socialize by imitating their adult tutors. Also, zebra finches have a critical learning period for developing their song, just as humans have a critical learning period for developing language. This identical learning process makes zebra finches a suitable animal model to simulate the development of language in humans. Mutations to several genes, including methyl CpG binding protein 2 (MeCP2) and Forkhead box G1 (FOXG1), have been implicated in hindering the language or speech learning process in mammals; however, these genes have still been relatively unexplored in zebra finches. In humans, FOXG1 acts as a transcription factor that regulates numerous downstream genes involved in early brain development. Mutations to this gene can lead to FOXG1 syndrome, characterized by physical and cognitive difficulties in addition to language or speech impairment. Likewise, the MeCP2 gene has been shown to have a role in transcription repression in response to epigenetic biomarkers but was implicated in impacting speech/language development due to its association with Rett (RTT) Syndrome. Approximately 90% of RTT syndrome patients have mutations to the gene MeCP2, and often present with impaired language and speech development. Although our understanding of how MeCP2 and FOXG1 directly impact vocal development is incomplete, both of these genes have been heavily connected to speech and language progression and are ideal targets for further inquisition.

Forkhead box P2 (FOXP2), a transcription factor related to FOXG1, plays a critical role in the regulation of vocal learning. From past experiments, it has been demonstrated that FOXP2 has heightened expression in the neural song network of zebra finches and is developmentally regulated. Considering their overlapping roles in language learning, we hypothesized that FOXG1 expression would be concentrated in the song nuclei regions of the brain, specifically in Area X, the high vocal center (HVC), the robust nucleus of the arcopallium (RA), and the lateral magnocellular nucleus of the anterior nidopallium (LMAN). Similarly, given its connection to speech and language development, we expect MeCP2 will see similarly concentrated expression patterns in the sing circuit. Furthermore, considering the critical learning period of zebra finches, it is expected that the expression of these genes will be developmentally regulated with notable fluctuations between the juvenile and adult life stages. To test this, we collected zebra finch brains at four different time points (30 days, 45 days, 60 days, and adulthood), and performed immunohistochemistry to visualize gene expression.