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Data Exploration Proposal

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For this project, we will study the auditory cortex of male zebra finches and more precisely neurons in 2 brain areas, the mesencephalicus lateralis dorsalis (MLD) located in the upstream auditory midbrain nucleus and the downstream auditory pallial region, (FLD). We are interested in understanding how different brain areas encode certain kinds of auditory stimuli based on when they receive the information. In fact, it is known that, when receiving an auditory stimulus, the neurons close to the auditory canal encode simple features about its frequency as well as time-related aspects. On the other hand, it also acknowledged that neurons further down the processing stream are involved in higher-level processing such as the categorization of auditory stimuli. However, there is less information about the selectivity process that is conducted by intermediate areas. In other words, there remain some questions regarding how non-significant stimuli are filtered out while relevant stimuli are more strongly encoded.

To learn more about this topic, we will study the differences in spiking rates across the two brain regions (MLD and FLD) for the same stimulus because of their different location alongside the auditory processing stream. Since we also have synthetic and natural stimuli, we will see if they generate different spike trains in the same neurons and more importantly, if those spikes differ across brain regions. For synthetic stimuli, we would expect more spiking rates in the MLD neurons than in the FLD cells since such stimuli should have been filtered out during the auditory processing due to their non-relevant nature. Indeed, the MLD comes before FLD throughout the auditory processing stream. Conversely, we expect to see similar spiking rates across those two regions for natural stimuli since they are relevant to the birds.

In order to answer those questions, we would first plot some raster plots to visually detect any differences in responses across brain regions and for different types of stimuli. We could compare spiking rates of one stimulus to another's thanks to a pairwise distance matrix analysis. By computing those distances, we will be able to estimate how similar two responses are. Using the distance calculations, we may be able to classify stimuli presented based on the relative difference between neuronal responses. Finally, we could try to add some decoding models to categorize the type of a presented stimulus, based on the responses generated.

Paper where the data comes from: https://www.physiology.org/doi/full/10.1152/jn.00128.2010
Paper regarding auditory models:
https://pdfs.semanticscholar.org/4dc2/7af6c7bcb5d80b20fdafff3f4dc0cf7d785d.pdf