HOMEWORK 1 - BEN HENDERSON

1. *Organization of the brain - short answer*

Patients with lesions in Wernicke's area lose the ability to comprehend speech as opposed to formulation of speech. Lesions to these regions in deaf populations still result in the inability to sign and to comprehend sign language respectively. This means that these areas aren't simply for speech more generally for higher order linguistic mapping.

2. *The Stroop Effect*

On the baseline test, I scored 31 seconds and on the Stroop test I scored 58 seconds (almost double!). Contradictory streams of visual information were competing to influence the activity of Broca's area. Top down inhibitory control attempted to filter out the incorrect response but it wasn't always sufficient. If I squint my eyes to where I cannot read the words, I would perform better.

3. *Distributed Functions*

Deciphering decision making would probably prove difficult because it is a complex series of neural computations from various cortical and deep brain structures. If you are limited to recording electrodes on the surface of the cortex, a lot of the computation is not captured in those recordings.

4.*Similarity of Function Across Species*

The firing of place cells functions as a neural representation of locations the animal is physically moving through. Different place cells will fire in response to different restricted locations. Grid cells fire in response to a receptive field patterned in a triangular array in physical space. These two neuronal cell types lay a foundational understanding for building a "mental map" of a physical landscape.

Species-specific ethological needs play a large role in whether this neural representation will be necessary for an animal's survival. In this example, food caching behaviors rely on advanced spatial memory functions. A bird that displays this behavior must have the capacity to store a lot of spatial information. A bird that does not display food caching behavior may not need such advanced spatial memory skills.

5. *Attention and Top-Down vs Bottom-Up*

Perception is not only shaped by bottom up feedforward networks driven by sensory inputs, but also from top down feedback loops performing inference on limited information. When looking at the fixation point, we have lower resolution of the event happening in our peripheral vision. This is informed by the "guess work" of the top down networks. When looking directly at the event, we received a higher resolution image that does not require the same level of top-down inference that would otherwise produce the visual illusion.

6. ***Passive Membrane and the Hodgkin Huxley Model of Action Potentials***

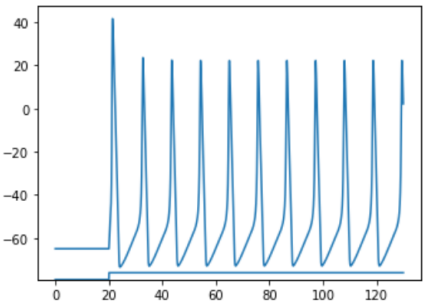
a. The equilibrium potential of Potassium is -77.03588742236381 mV
The equilibrium potential of Sodium is 53.64613626398457 mV
The equilibrium potential of Chloride is -88.754925227954 mV

b. Using the GHK equation, the net equilibrium is -67.09367055791867 mV

c. Due to extracellular potassium rising to 14mM, the new equilibrium potential of Potassium is -62.328398774221334 mV.

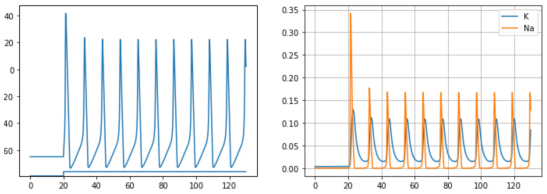
7. Passive Membrane and the Hodgkin Huxley Model of Action Potentials

a. When extending the duration of current injection, it is apparent that the rate at which action potentials occur is 10 Hz.

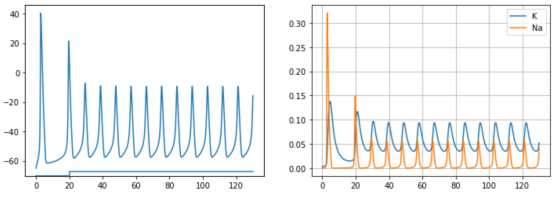


b. Using the GHK equation, the net equilibrium potential is -58.75 mV when the equilibrium potential for K falls to -62 mV. Using the neural simulation the threshold potential is reached faster as a result and spontaneous firing is seen prior to current injection.

Keq = -77

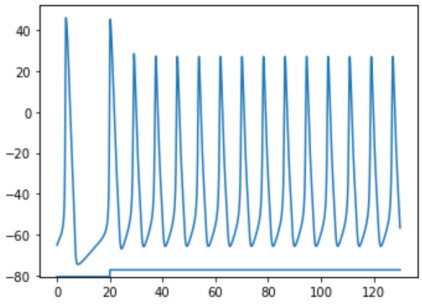


Keq = -62

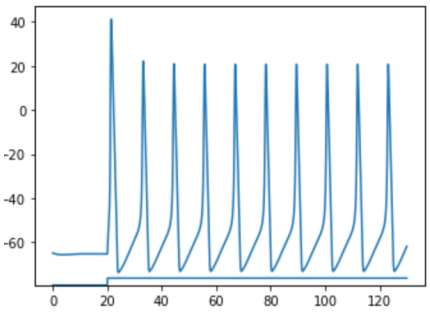


c. To decrease the rate at which action potentials occur, you should increase the potassium conductance.

gK = 0.1

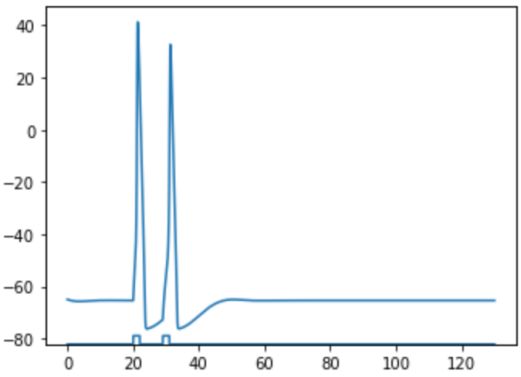


gK = 0.4

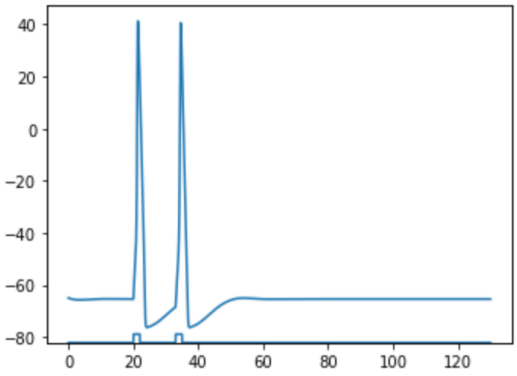


d. The minimum delay between 2ms current pulses for which the action potential amplitudes will all be the same is approximately 9-10 ms.

Delay = 7 ms



Delay = 9 ms



8. ***Structure and Function of Neurons in the Superior Colliculus***

The superior colliculus is a layered structure. The most superficial layer receives visual inputs, intermediate layers receive multimodal inputs (including auditory inputs) and deeper layers are involved in motor output. Sensory inputs from a certain location in space correspond to the motor output of orienting the animal towards those stimuli.

Widefield vertical neurons are involved in the detection of the cricket from far away and narrowfield vertical neurons are involved in catching the cricket when it is nearby.

The longer and more numerous dendritic arbors of widefield neurons allows them to receive inputs from a wider range of inputs. This translates to the detection of a cricket existing

somewhere nearby but doesn't provide the acute information of the specific location in space relative to the mouse.

The less numerous dendritic branches of the narrowfield vertical neurons allows for a more acute sensory input in space to direct the mouse’s motor output with more precision following initial broad range detection.