# NEUROMORPHIC ROBOTIC ATTENTION: A SPIKE-BASED OCULOMOTOR CONTROLLER

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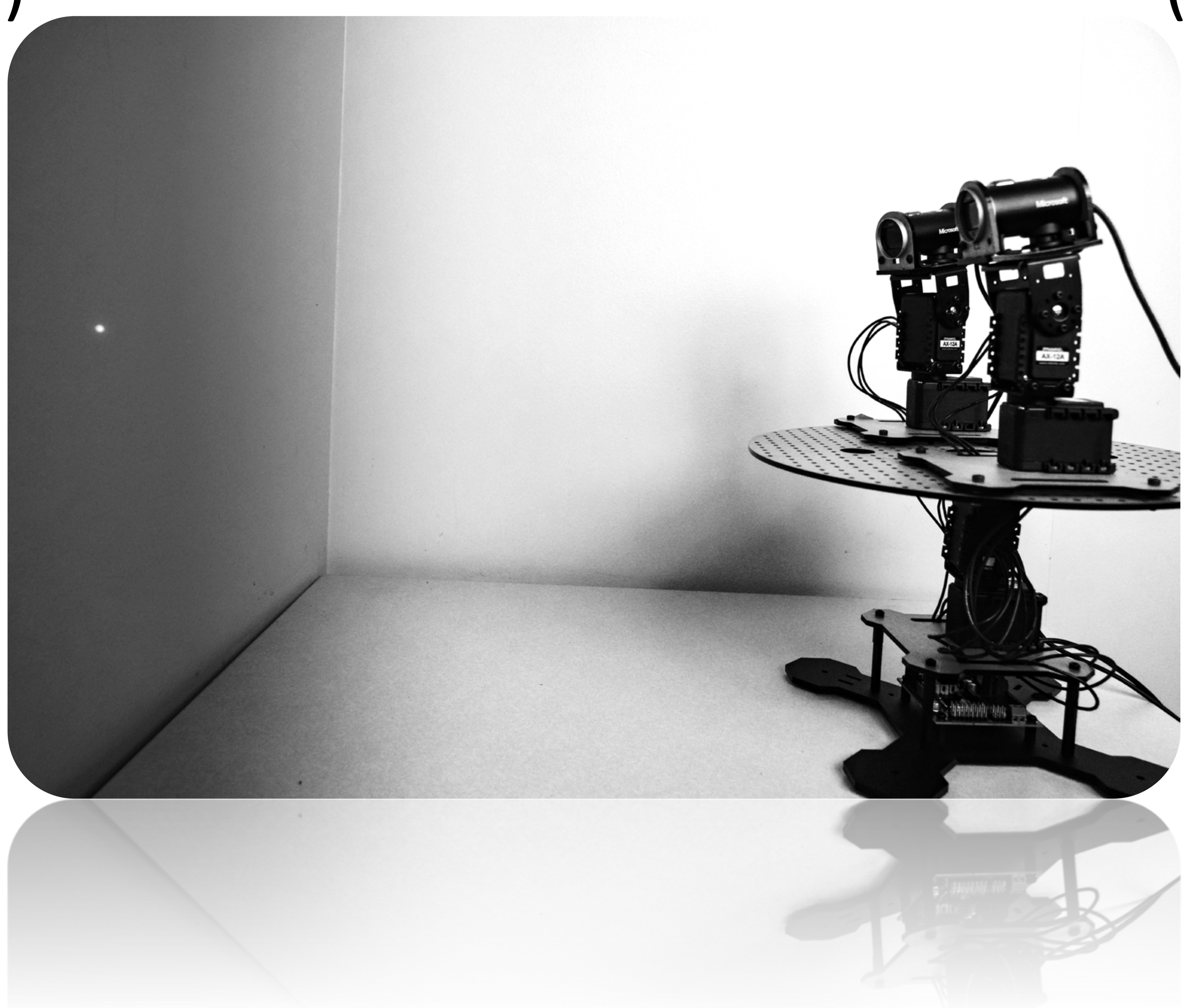
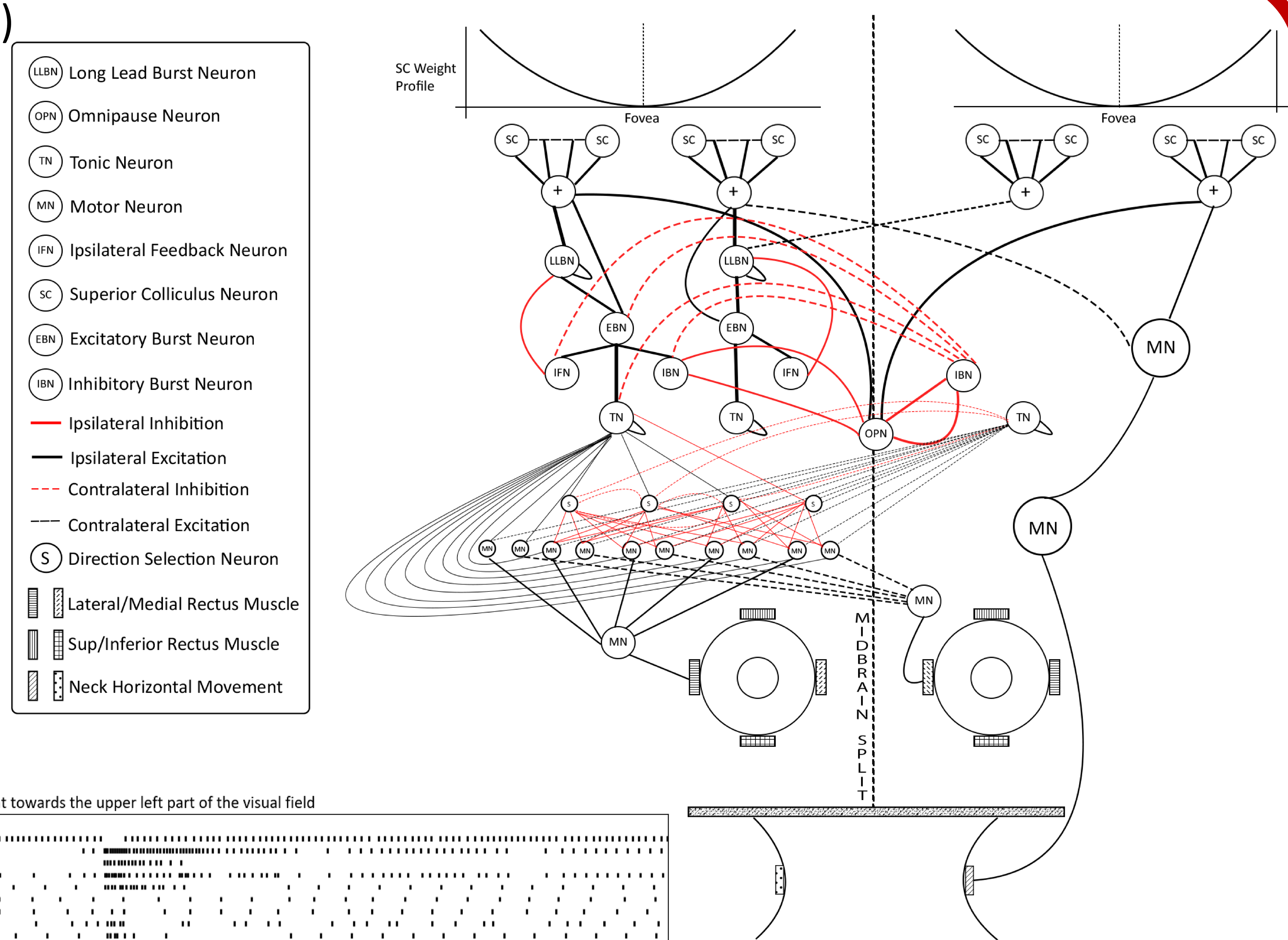
(a)



(b)




(c)

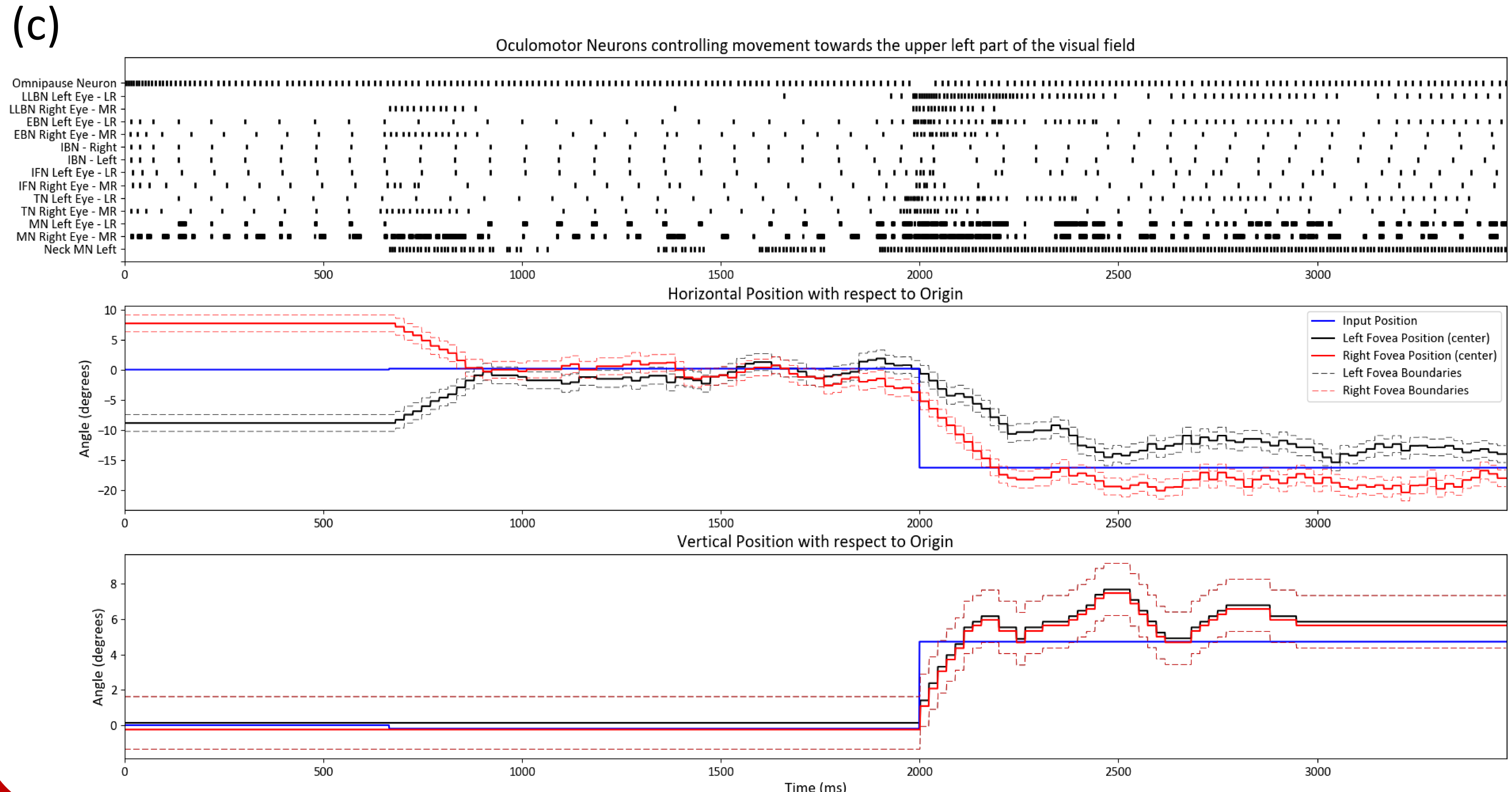



**Fig 1(a)** Experimental setup with the robotic head facing a wall with the target laser pointer. **(b)** Biomimetic Saccade and smooth pursuit controller neural network model. The MNs are the motor neurons that innervate with rectus muscles of the eye and the muscles of the neck. The neural network model shows the neurons involved in the horizontal conjugate and vergence movements in one direction and horizontal movements of the neck. A similar network is present in the other half of the brain to control horizontal movements in the opposite direction. **(c)** Raster plot for relevant neurons in cculomotor response to a target positioned on the top left part of the visual field; fovea position with respect to the origin assumed to be at the midpoint between the two eyes.

## INTRODUCTION

Robotic vision introduces requirements for real-time processing of fast-varying, noisy information in a continuously changing environment. Leveraging on the physiological evidence that smooth pursuit and saccade are handled by the same neural circuitry [1], we designed a neuromorphic oculomotor controller and placed it at the heart of a biomimetic robotic head prototype that we have developed at ComBra Lab.

## MODEL

Our proposed neuro-mimetic network allows for tracking of a single target. The network is driven by the neurons of the superior colliculus [3], which are known to represent the centers of visual receptive fields to generate a burst of spikes that encodes motor signals [2]. The firing rate of the motor neurons encode the distance and direction of motion which is directly converted into a voltage signal driving the servos.

## CONCLUSION

The biomimetic robot was designed to track a laser pointer on a wall. Using principles from neuroscience and a model adapted from the human visual system, we achieved real-time tracking of a visual target. Future research will focus on embedding spike-based saliency maps and learning to follow the most salient target, under certain criteria.

## REFERENCES

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[3] Van Horn, Waitzman, Cullen (2013). "Vergence Neurons Identified in the Rostral Superior Colliculus Code Smooth Eye Movements in 3D Space." The Journal of Neuroscience 33(17):7274-7284.