Project Proposal:
Attentional Effects on Neuronal Firing - An Interactive Visualization

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Overview

I have chosen to *develop an artistic or musical representation of the synapse in action, using any media*. Specifically, I plan on creating a web-based **interactive visualization** of the effects of attention on neuronal firing. Several studies I have looked at discuss the way in which visual attention modulates communication in neural circuits by increasing neuronal firing and synchrony [1].

I want to create a visual representation of a neural circuit in area V4 and simulate this enhanced neural response in an interesting and artistic way. To simulate attention, users will use their webcam to track their eye movement and thus indicate when they are looking directly at their computer screen (when they are "attending to stimuli in the receptive field") and when they are not looking at their screen (when their attention is "directed away from the receptive field"). When the users are "attending," the application will visually simulate the resulting effects on neuronal firing.

I envision my web app interface to be divided into two sides: one on which various visual stimuli will be presented, and one on which the visual interpretation of the neural circuit will reside. At the most basic level, the side with the neural circuit will visualize the way in which a network of pre- and post-synaptic neurons interact with one another on a macro-level by the demonstrating the frequency and synchrony of their firing. I may try to develop a "zoom" feature that allows the user to look at this symphony of activity at varying levels of detail so that they also have the option of viewing the actual synaptic transmission.

From my research, it seems that there are two models for how attention may modulate a neuron's contrast-response function: the contrast gain model, and the response gain model [3]. I think it will be interesting to explore how these two models work, and figure out a way to map them to a dynamic visualization.

My application will serve as both an interactive art piece and an exploration of the ways in which attention affects neuronal responses in V4.

Tools/Methods

- I will use **JavaScript, HTML5, and CSS3** to develop the web application.
- I will use a **head or eye tracking JavaScript library** for webcam (similar to the one used in Eye [2]) to determine when the user is focused on the screen.

- I will use **Adobe Illustrator** to create an artistic representation (interpretation?) of neurons and synapses.
- I will use **Processing**, an open-source programming language tailored to the development of electronic arts, new media art, and visual design, to translate these visual representations into a network of dynamic, interactive elements.

References

[1] Farran Briggs, George R. Mangun, and W. Martin Usrey. Attention enhances synaptic efficacy and the signal-to-noise ratio in neural circuits. *Nature*, 2013.

[2] Ryhan Hassan. Eye - js eyeball that uses your webcam to follow you around: https://github.com/ryhan/eye.

[3] John H Reynolds, Tatiana Pasternak, and Robert Desimone. Attention increases sensitivity of {V4} neurons. *Neuron*, 26(3):703 – 714, 2000.