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Project Summaries

BrainsCAN

2019

Multi-area organization of saccade-evoked traveling waves

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Multi-area organization of saccade-evoked traveling waves

Background

Visual perception is essential to humans and other primates. We generally know that the organized activity of neurons in the cerebral cortex allows us to perceive shape, colour and entire objects, but we don't really understand how this process happens.

We know that our brains have 'retinotopic maps', mapping visual input from our retinas onto neurons in the visual cortex. These retinotopic maps establish a precise coordinate system for incoming visual input and help us to process visual inputs, integrate features into coherently perceived objects and decode visual motion - visual perception.

The Problem

In humans and other primates, the eyes are rarely still. When reading or looking at our immediate surroundings, our eyes make very small involuntary movements known as saccades. These saccadic movements are very fast (up to three to six times a second) and are more like tiny jumps from position to position. This allows the eye to use the small 'high-resolution' portion of the retina (known as the fovea) to assess a whole scene.

Given this rapid, almost constant movement of the eye, the visual system in the brain must always re-calibrate its coordinate system to reflect the visual world after each saccade. This re-calibration is a topic of debate in visual neuroscience. Despite the saccadic movements, visual perception is stable. What neural mechanism is underlying this perceptual stability during saccades?

Recent work has shown that visual saccades trigger a specific pattern in a region of the visual cortex - 'neural traveling waves' in the electrical signals of neurons that propagate from foveal to peripheral areas of the retinotopic map. These neural traveling waves modulate the firing of neurons in the visual cortex, causing a reorganization of activity during the time of the visual saccade. We believe these waves allow groups of neurons to process visual signals quickly and accurately. However, the

Funding Program

BrainsCAN Accelerator Grant: Stimulus
Awarded: $100,850

Additional BrainsCAN Support

NHP Core
Computational Core
Imaging Core

Western Faculty, Group or Institution

Department of Physiology & Pharmacology, Schulich School of Medicine & Dentistry

Keywords

Novel neuroscience/neuroimaging techniques, vision/visual perception

Related

None

underlying biological mechanisms of these traveling waves and their function in saccades remain largely unexplored.

The Project

In this project, we will employ new, large-scale electrophysiological recording techniques to sample widely across the visual system. It will allow us to test our hypothesis that neural traveling waves coordinated across multiple areas contribute to perceptual stability during eye movements. Using our newly developed signal processing technique to track traveling waves moment-by-moment in noisy multichannel data, we will detect and quantify them across multiple visual areas. The results from these analyses will allow us to:

* understand the underlying network mechanisms generating these neural traveling waves,

* determine whether they are a general phenomenon in our type of visual system, and

* determine whether they provide a neural basis for perceptual stability during saccades.

This transformative research project will bring together the development of new recording technologies, a new model system for primate vision and new computational techniques for tracking moment-by-moment neural activity patterns. It will address a unique hypothesis about the coordination of activity in multiple cortical areas with great detail during natural behaviour.

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