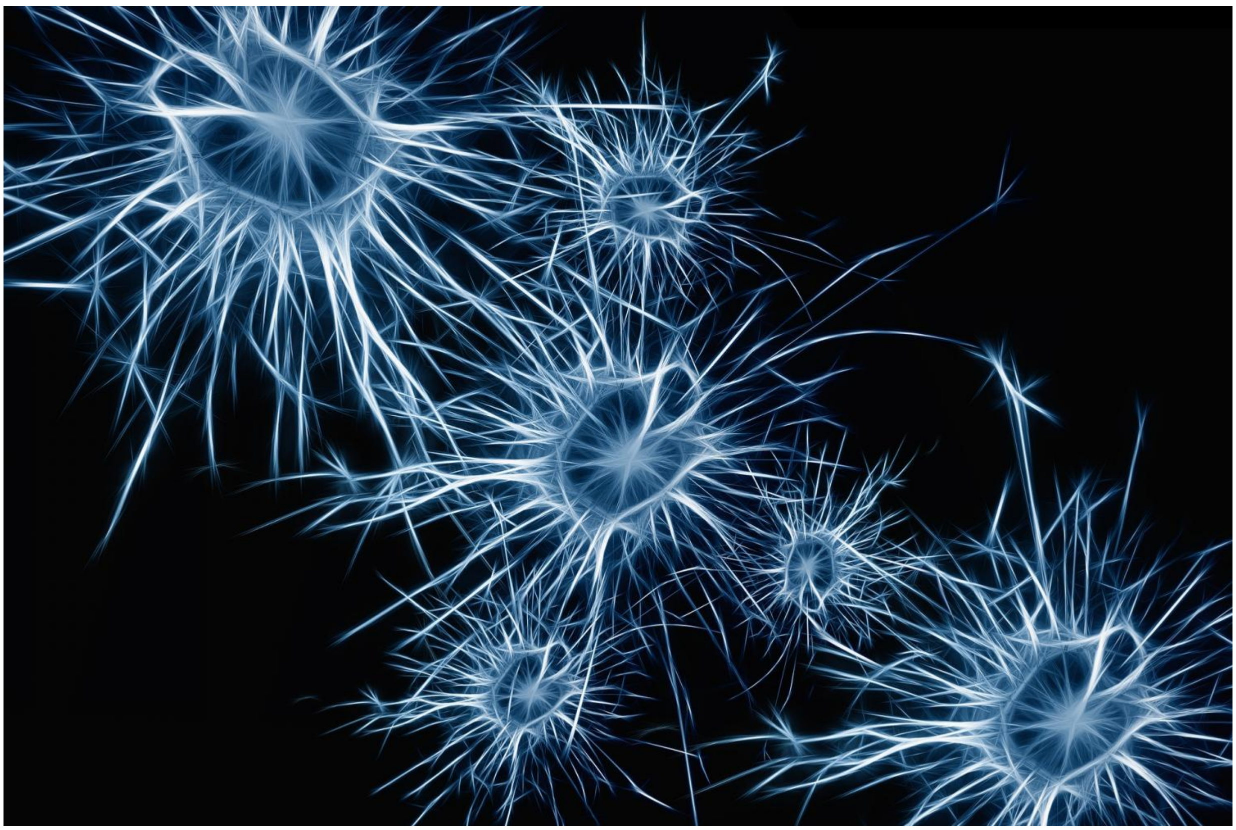
Circuit found for brain's statistical inference about motion

September 17 2018



Credit: CC0 Public Domain

As the eye tracks a bird flying past, the muscles that pan the eyeballs to keep the target in focus set their pace not only on the speed they see, but also on a reasonable estimate of the speed they expect from having watched birds before.

A team of Duke University neuroscientists has found the neural wiring underlying this predictive behavior and watched in monkeys as the circuit is set to predict a given speed. They say the neurons of the brain's sensory and motor systems are guided by a combination of past experience and sensory inputs.

When replicated in a neural network computer, these educated guesses made by motor neurons mimic Bayesian statistical inference, said Stephen Lisberger, the senior author on the paper and George Barth Geller Professor for Research in Neurobiology at Duke. Bayesian inference relies on the probability of a given outcome and updates it as more evidence becomes available.

The researchers built a mathematical model of the circuit that pitted prior experiences against a form of sensory input and adjusted the weight of its connections accordingly, just as the real life version does in its synapses.

"The model behaves just like the neurons," Lisberger said. The team was able to render the neural responses as a series of equations that fit with Bayesian logic.

The work appears Sept. 17 in *Nature Neuroscience*.

"Motor control is guided by this reliability coded information," Lisberger said. The memory of past experience is established by the strength of the synapses in the neural circuit that drives what are known as pursuit eye movements, and those synapses can be rapidly modified as experiences change. The heart of the system is an area of the brain that governs smooth eye movements in the frontal eye fields, FEFsem, for short.

Many papers in neuroscience over the last few years have showed the brain's capacity to use inference and predictions based on past experience to temper its use of its sensory inputs. "To our knowledge this is the first time anyone has a found a place perfectly situated to cause the behavioral outputs we see," said Lisberger, who is also a member of the Duke Institute for Brain Sciences.

The entire pursuit eye movement circuit, from the retina to the brain and back out to the eye muscles, is known to the researchers and they can measure any single neuron withinit. They recorded the activity of single neurons as monkeys tracked moving targets and adapted their pursuit eye movements to changing speeds.

The team's experiments also showed that when a visual target is made less visually distinct by lowering its contrast or brightness, the importance of estimates based on past experience becomes greater. "It's like when you're driving a familiar road at night or in the fog—you go by what you know is going to happen next as much as by what you can actually see," Lisberger said.

"In low light, FEFsem says, 'don't track that,'" Lisberger said. "But if it's a bright patch, it says 'tune in, get it.'" This insight would enable them to predict eye movements by looking at just the neurons, he said.

More information: Timothy R. Darlington et al, Neural implementation of Bayesian inference in a sensorimotor behavior, *Nature Neuroscience* (2018). DOI: 10.1038/s41593-018-0233-y

Provided by Duke University

Citation: Circuit found for brain's statistical inference about motion (2018, September 17)