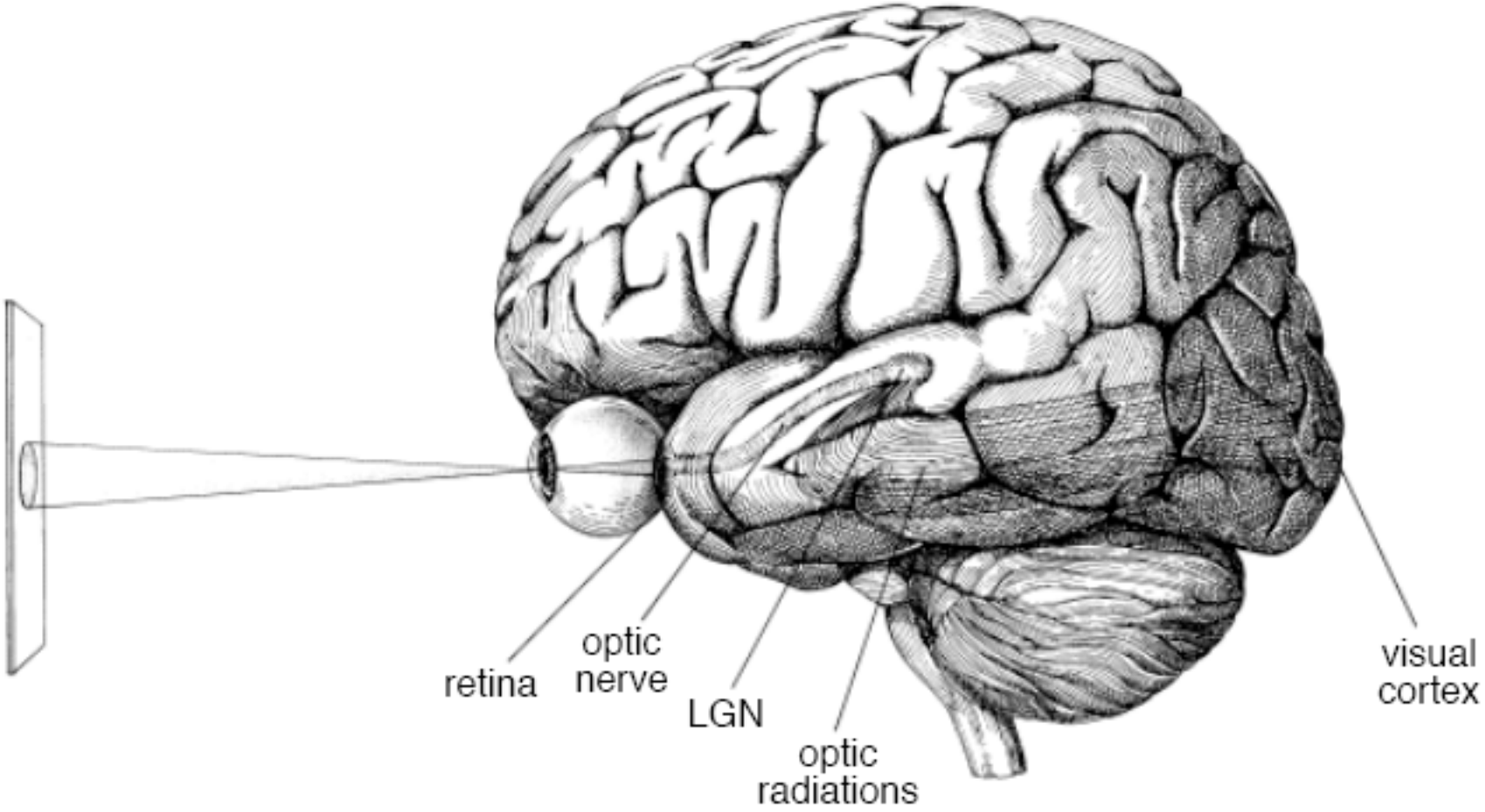
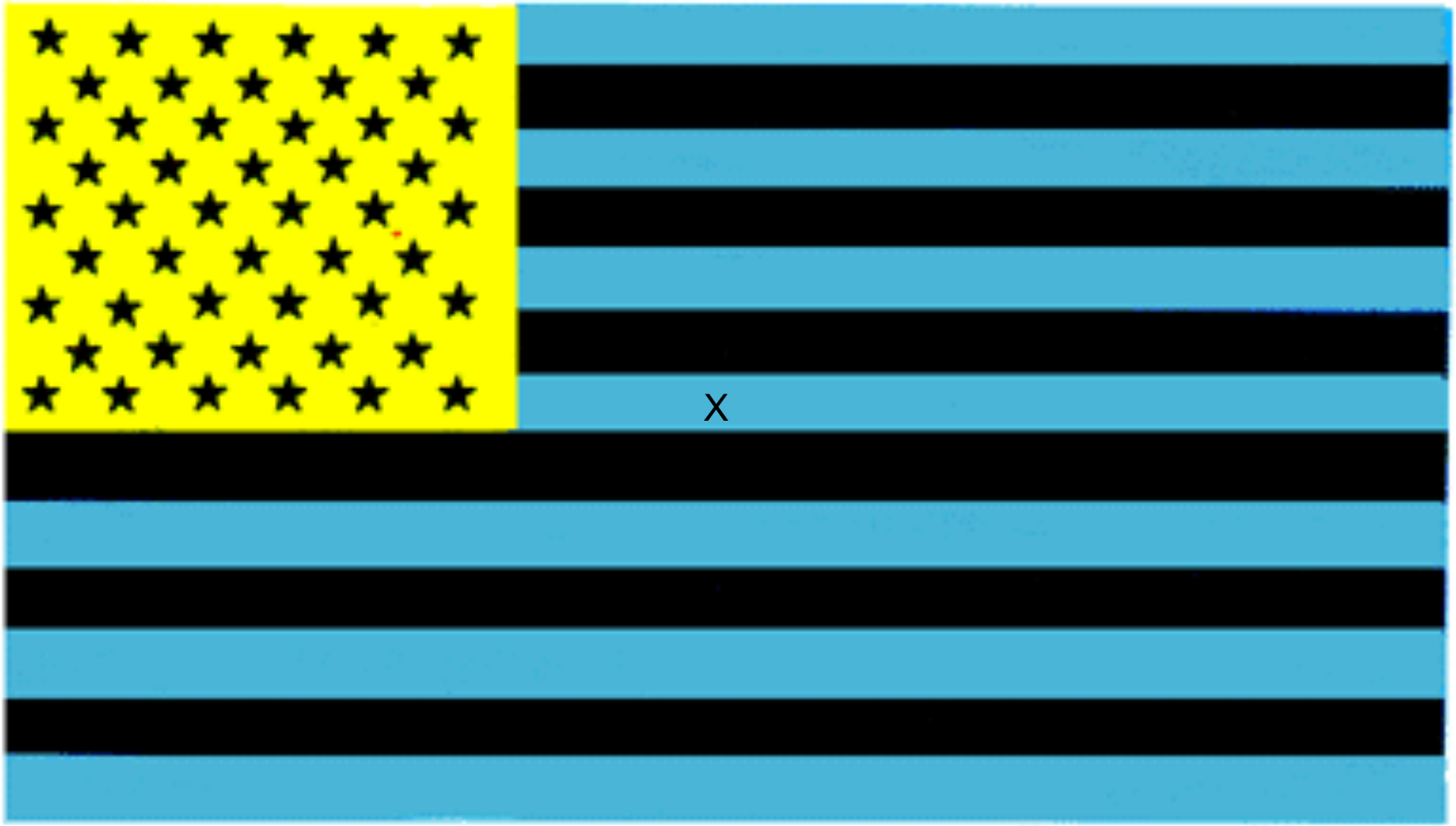
Neural Circuit Disorders

- Numerous neurological disorders, including schizophrenia, depression, autism, Parkinson's disease, Alzheimer's and attention disorders, result from a malfunction of brain circuitry.
- Understanding the causes and developing treatments requires an understanding of brain circuitry.
- However, the normal brain circuits affected by these disorders are poorly understood.

Visual illusions show that perception is created by the brain.

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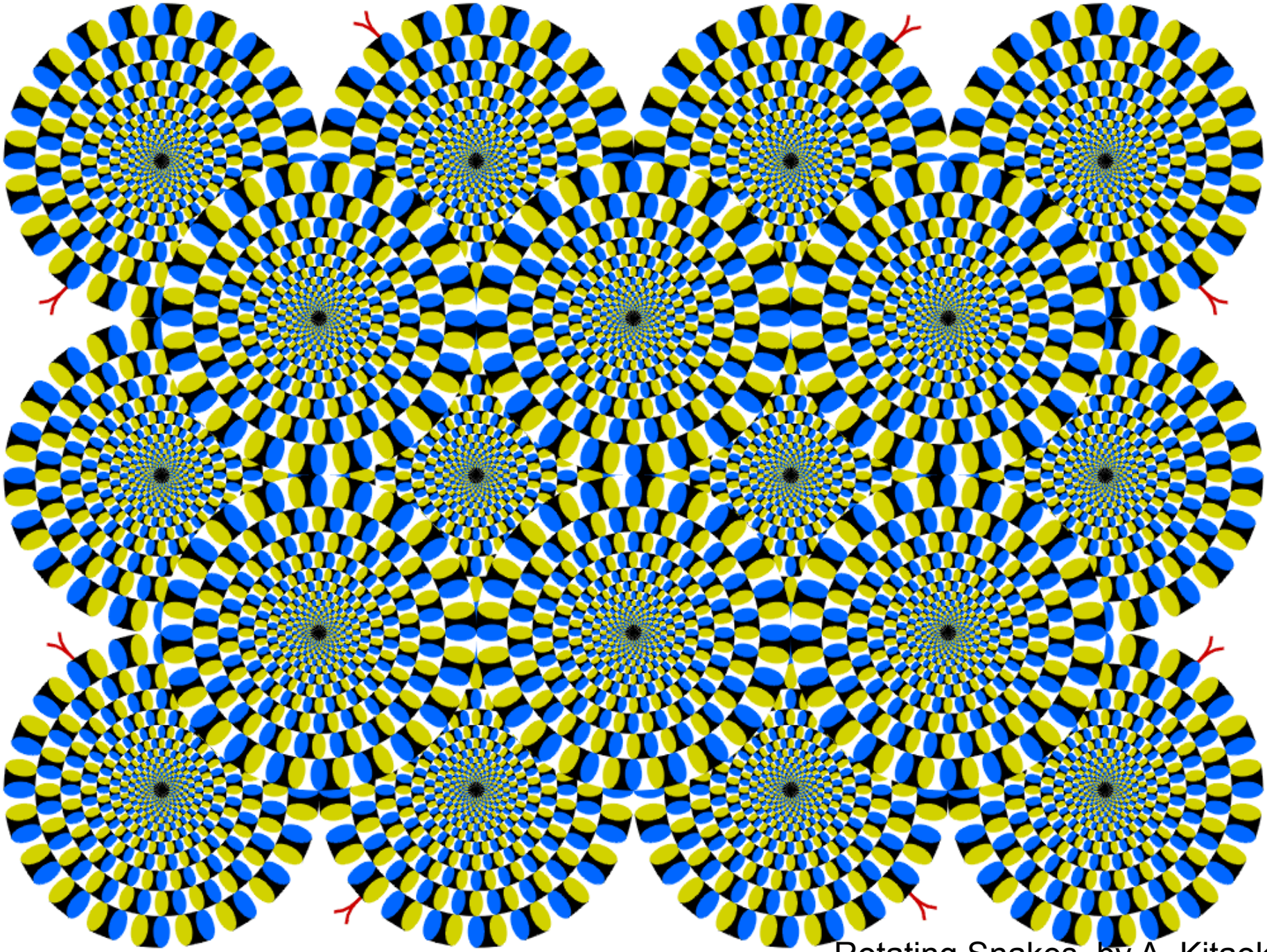
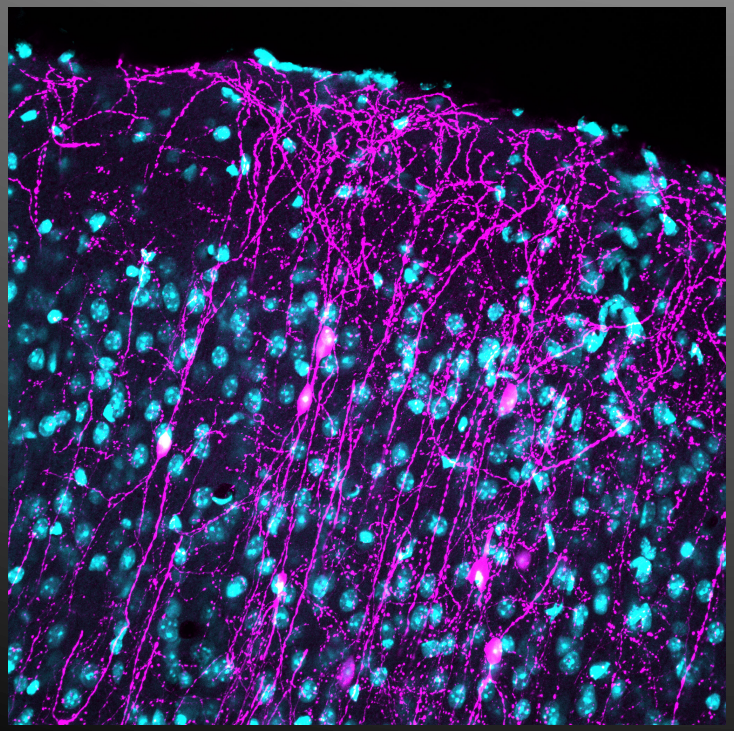
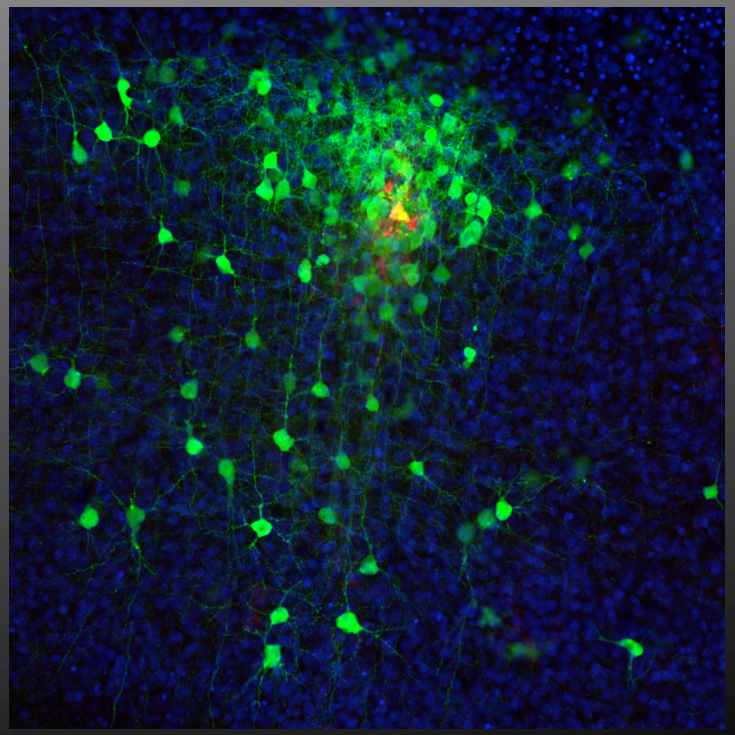


Rotating Snakes, by A. Kitaoka.

Perception is created by the brain… Using neural circuits. But how?

- If you don't know what's broken you can't fix it.
- Understanding how brain circuits work is necessary to understand neural circuit disorders.

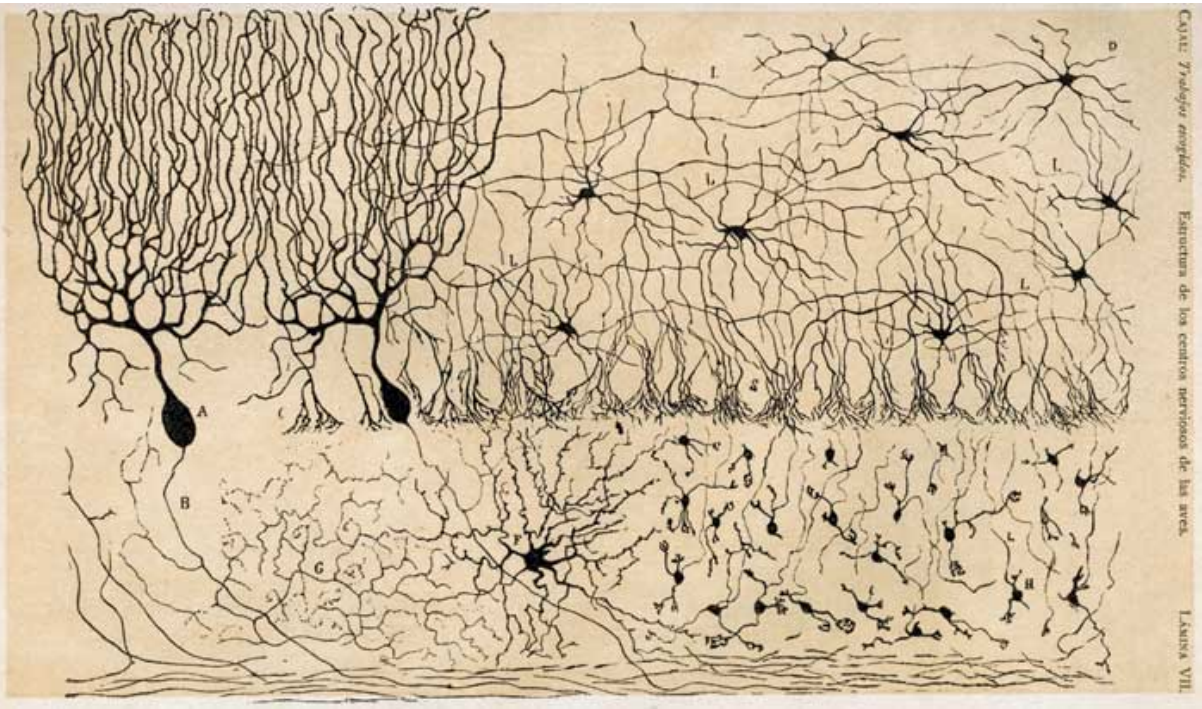




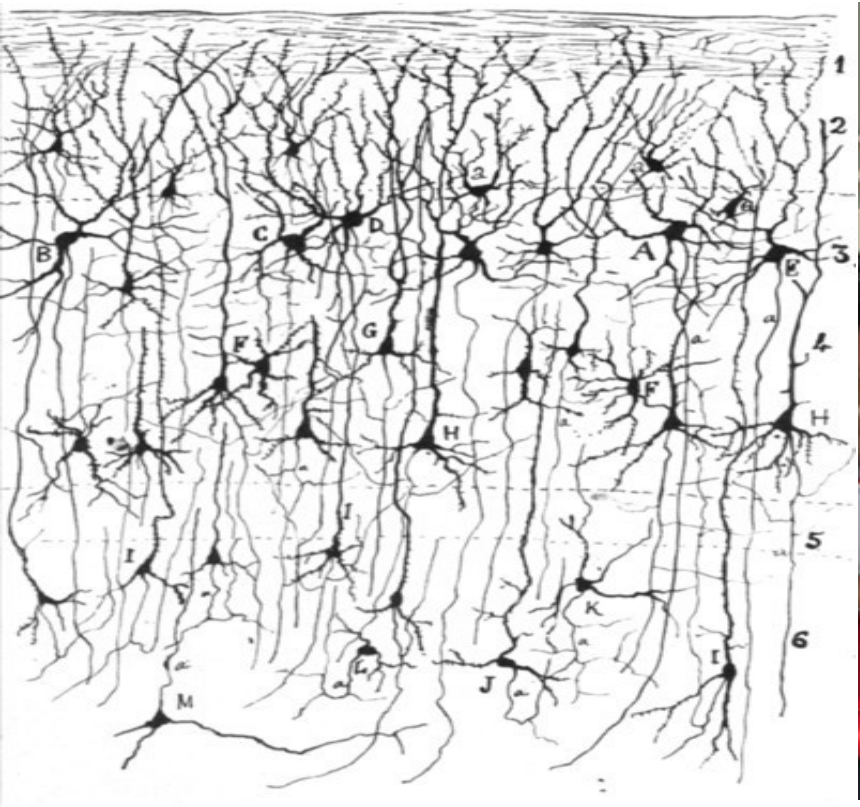
After a hundred years you still haven't figured it out?

Cajal established the Neuron Doctrine more than 100 years ago. The brain is composed of precise circuits formed by neurons.

He argued against the Reticular Theory, in which the brain is a meshwork of connected fibers.

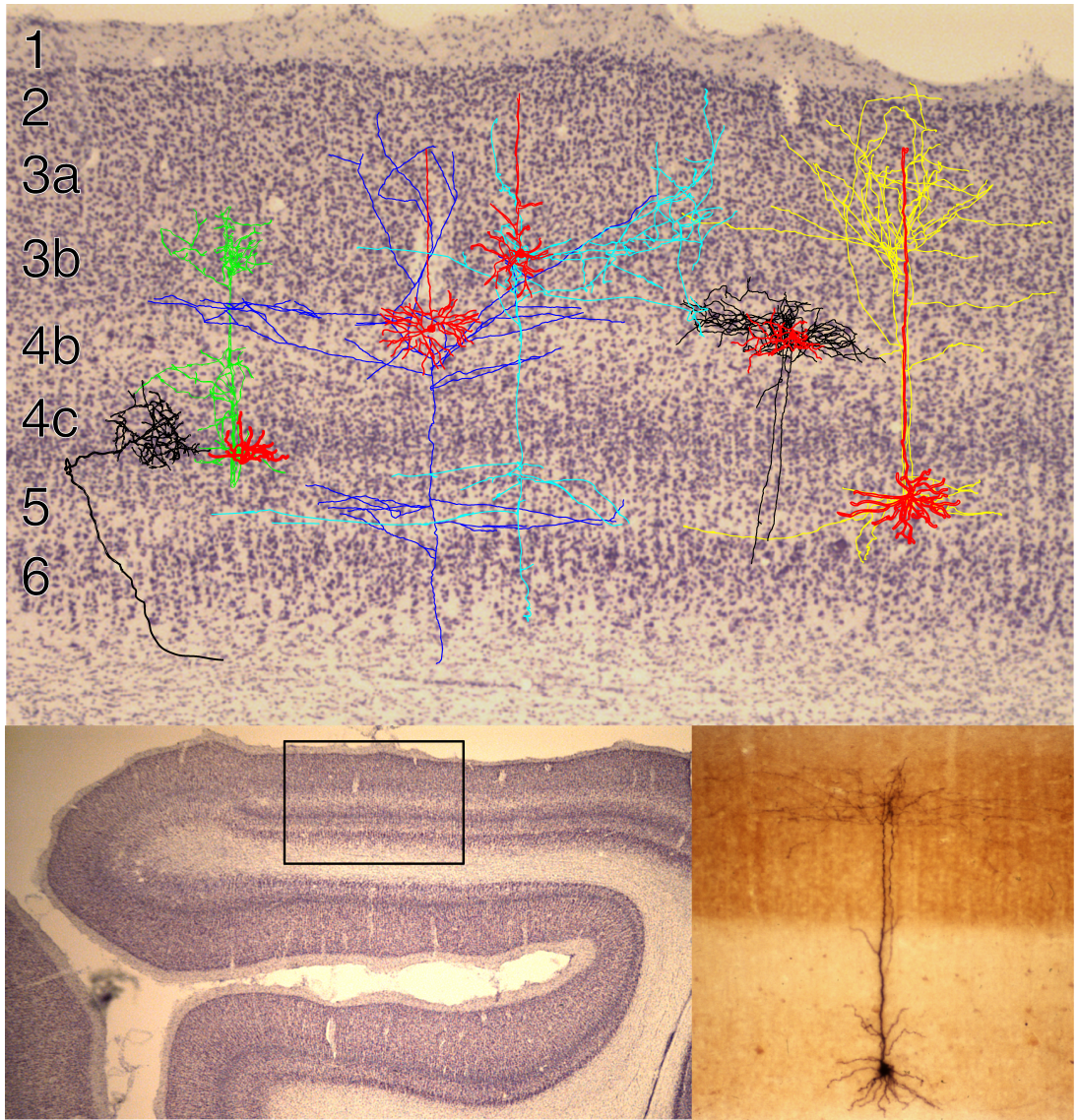


Why?
Because the brain is complicated….



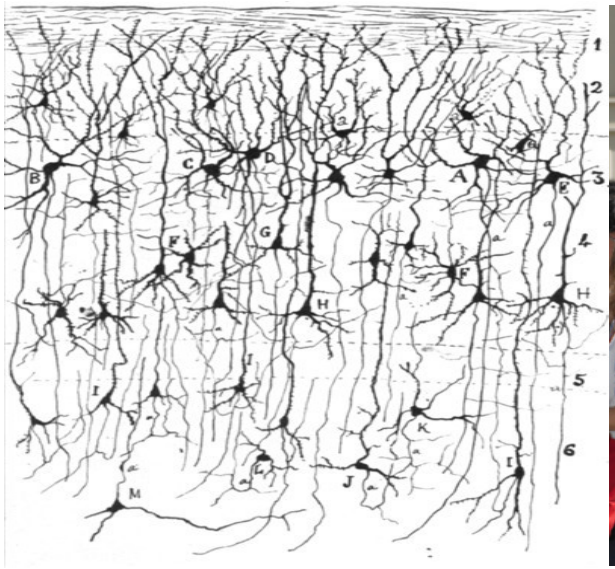
…which makes it difficult to find the circuits.

Why?
Because the brain is complicated….



What are you doing about it?

We have to find out which brain cells are talking to each other and what they are saying.



We're building and using new tools.

We are in the midst of a revolution in the study of neural circuits.

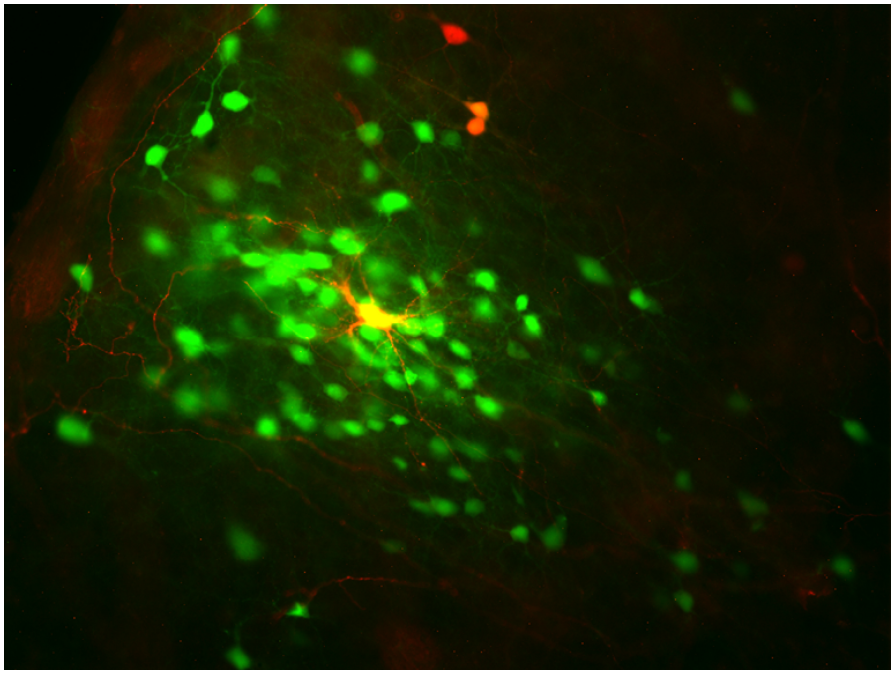
We can now reverse engineer the brain.

Existing molecular, genetic and viral tools allow us to:
Trace Connections – who talks to who?
Monitor Activity – what are they saying?
Manipulate Activity – infiltrating the network.

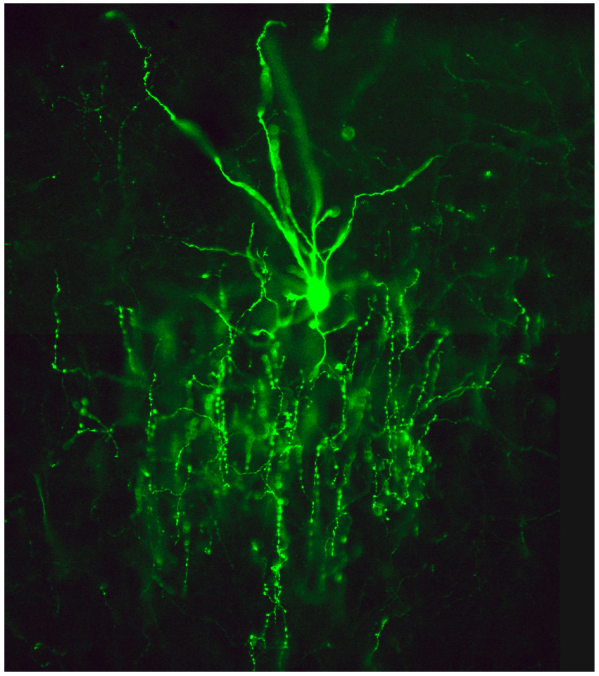
In defined circuits and cell types.

The Future of Neural Microcircuits

1) Revealing Circuits



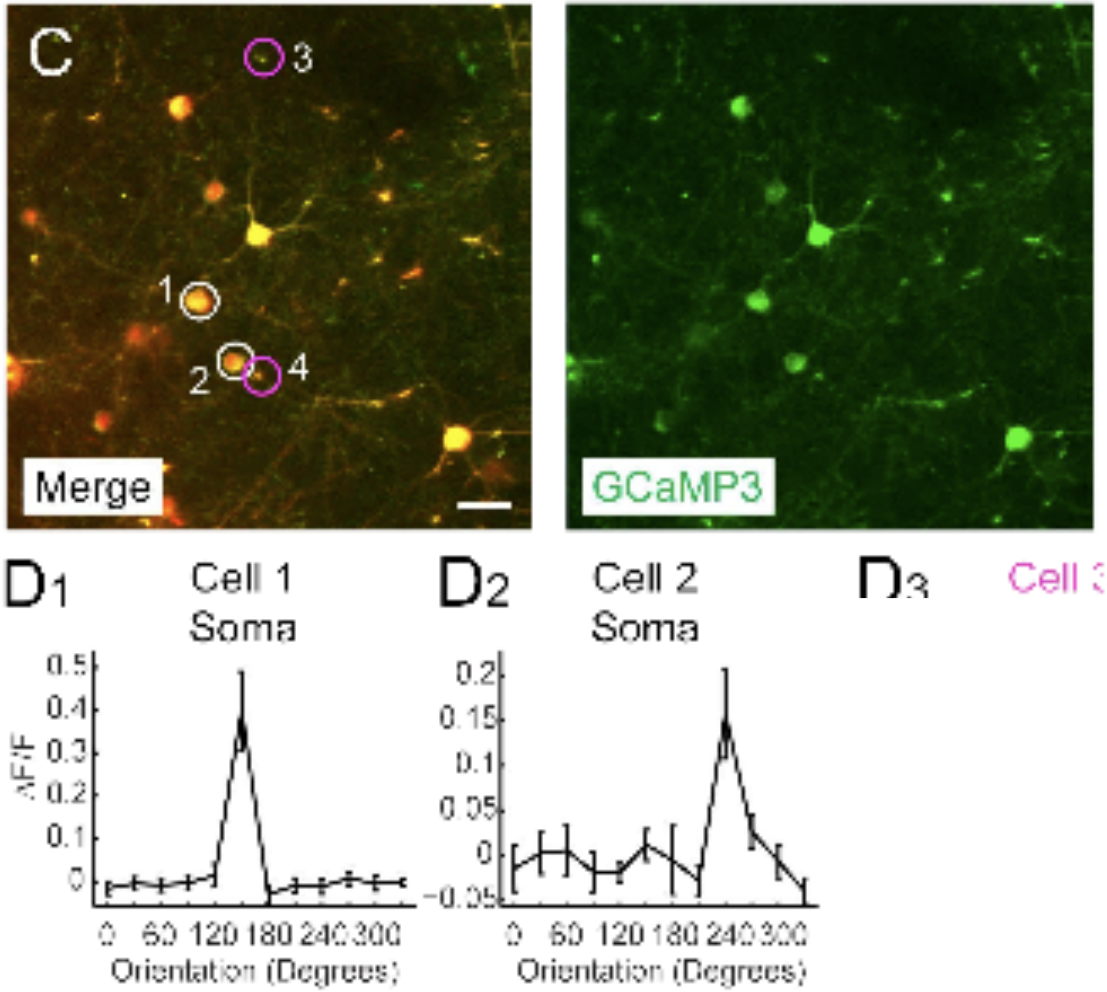
Transneuronal viral tracing labels connected cells in live animals.



Mouse lines and viral promoters allow targeting of gene expression to cell types.

The Future of Neural Microcircuits

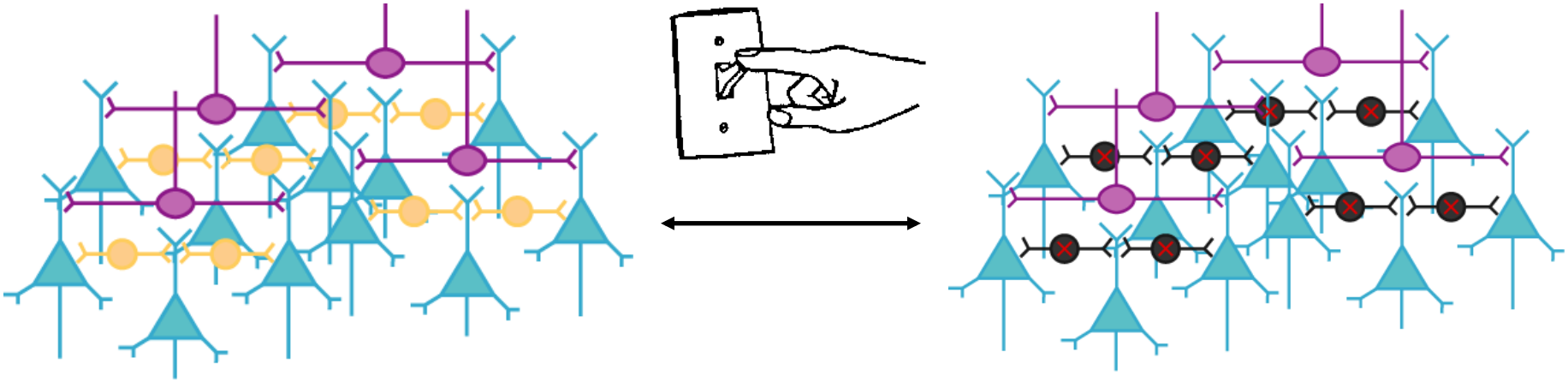
2) Linking Circuits to Function.



A genetically encoded activity indicator allows optical monitoring of activity in defined circuits or cell types.

The Future of Neural Microcircuits

3) Turning Circuit Components On and Off.



There is a wide range of optogenetic and hybrid genetic-pharmacological tools to activate or inact genetically targeted neurons.

We are in the midst of a revolution in the study of neural circuits.

- But it still will take time and money!
- The new methods have only been around for a few years and are still being developed.
- This is a focus of The BRAIN Initiative.

THE WHITE HOUSE IS ANNOUNCING

OVER $300 MILLION IN PUBLIC AND PRIVATE INVESTMENTS IN SUPPORT OF THE BRAIN INITIATIVE

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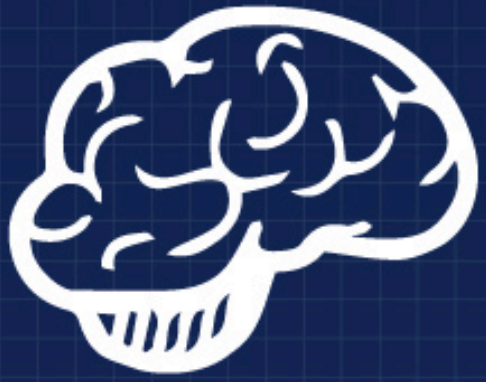
the WHITE HOUSE



BRAIN INITIATIVE

BRAIN RESEARCH THROUGH ADVANCING INNOVATIVE NEUROTECHNOLOGIES

Since President Obama announced the **BRAIN Initiative** in April 2013, dozens of leading technology firms, academic institutions, scientists and other key contributors to the field of neuroscience have answered his call and made significant commitments to advancing the Initiative.

ALLEN INSTITUTE for BRAIN SCIENCE
Fueling Discovery

The Gatsby Charitable Foundation

THE KAVLI FOUNDATION

Opportunities at the Interface of Neuroscience and Nanoscience

Convenors: Allen Institute for Brain Science, Gatsby Charitable Foundation, and The Kavli Foundation

Venue: Chicheley Hall, the Kavli Royal Society International Centre

Date: 10th-13th September 2011

Aims: The fields of neuroscience and nanoscience have both undergone significant transformation over the last ten years in regards to technology development. New tools are permitting ever more complex experiments to be carried out, and for the first time enabling neuroscientists to manipulate and interrogate circuits and individual neurons to tackle long standing biological questions.

The sponsors all have significant investments in one or both fields and are convening this meeting to exploit the opportunities at the interface of neuroscience and nanoscience, enabling an active discussion of the current state of play of these disciplines, where they intersect and where the gaps are for the fields to intersect in the future, known and unknown.

The White House
Office of the Press Secretary

For Immediate Release April 02, 2013

Fact Sheet: BRAIN Initiative

"If we want to make the best products, we also have to invest in the best ideas... Every dollar we invested to map the human genome returned $140 to our economy... Today, our scientists are mapping the human brain to unlock the answers to Alzheimer's... Now is not the time to gut these job-creating investments in science and innovation. Now is the time to reach a level of research and development not seen since the height of the Space Race."

- President Barack Obama, 2013 State of the Union

The New York Times

SCIENCE

Obama to Unveil Initiative to Map the Human Brain

By JOHN MARKOFF and JAMES GORMAN APRIL 2, 2013

President Obama on Tuesday will announce a broad new research initiative, starting with $100 million in 2014, to invent and refine new technologies to understand the human brain, senior administration officials said Monday.

A senior administration scientist compared the new initiative to the Human Genome Project, in that it is directed at a problem that has seemed insoluble up to now: the recording and mapping of brain circuits in action in an effort to “show how millions of brain cells interact.”

The New York Times

SCIENCE

Obama Seeking to Boost Study of Human Brain

By JOHN MARKOFF FEB. 17, 2013

The Obama administration is planning a decade-long scientific effort to examine the workings of the human brain and build a comprehensive map of its activity, seeking to do for the brain what the Human Genome Project did for genetics.