



A REPORT ON  
ADVANCES  
IN  
NEUROSCIENCE

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# THE CONTENTS OF THIS PRESENTATION

- New Initiatives
- New Methods
- New domains of interest
- New Findings

# INITIATIVES

- Brain Research through Advancing Innovative Neurotechnologies® (BRAIN) (85 million \$)
- **Human Brain Project** (€1.19 billion)
- **Human Connectome Project**
- **Blue Brain Project**
- **Cognitive computing**

# BRAIN OBJECTIVES

- #1. Discovering diversity: Identify and provide experimental access to the different brain cell types to determine their roles in health and disease.
- #2. Maps at multiple scales: Generate circuit diagrams that vary in resolution from synapses to the whole brain.
- #3. The brain in action: Produce a dynamic picture of the functioning brain by developing and applying improved methods for large - scale monitoring of neural activity.

- #4. Demonstrating causality: Link brain activity to behavior with precise interventional tools that change neural circuit dynamics .
- #5. Identifying fundamental principles: Produce conceptual foundations for understanding the biological basis of mental processes through development of new theoretical and data
- #6. Advancing human neuroscience: Develop innovative technologies to understand the human brain and treat its disorders; create and support integrated human brain research networks

- #7. From BRAIN Initiative to the brain: Integrate new technological and conceptual approaches produced in Goals #1 - 6 to discover how dynamic patterns of neural activity are transformed into cognition, emotion, perception, and action in health and disease.

# HUMAN BRAIN PROJECT

- [Neuroinformatics](#)
- [Brain simulation](#)
- [High-performance computing](#)
- [Medical informatics](#)
- [Neuromorphic computing](#)
- [Neurorobotics](#)

- Electrode Arrays for Recording Voltage and Passing Current
- Optical Sensors of Neuronal Activity
- Integrated Optical Approaches: Neuroscience and Instrumentation
- Nanotechnology and Unanticipated Innovations



# MANIPULATING CIRCUIT ACTIVITY

- optogenetic tools, generally based on Channelrhodopsin (depolarizing) and Halorhodopsin or Archaerhodopsin (hyperpolarizing)

# BEHAVIOUR

- virtual reality
- machine learning
- miniaturized recording

# HUMAN NEUROSCIENCE AND NEUROTECHNOLOGY

- MRI, DT-MRI, fMRI, rfMRI
- PET and neurochemistry
- EEG, MEG

# DEVICES FOR MONITORING AND STIMULATING THE HUMAN BRAIN

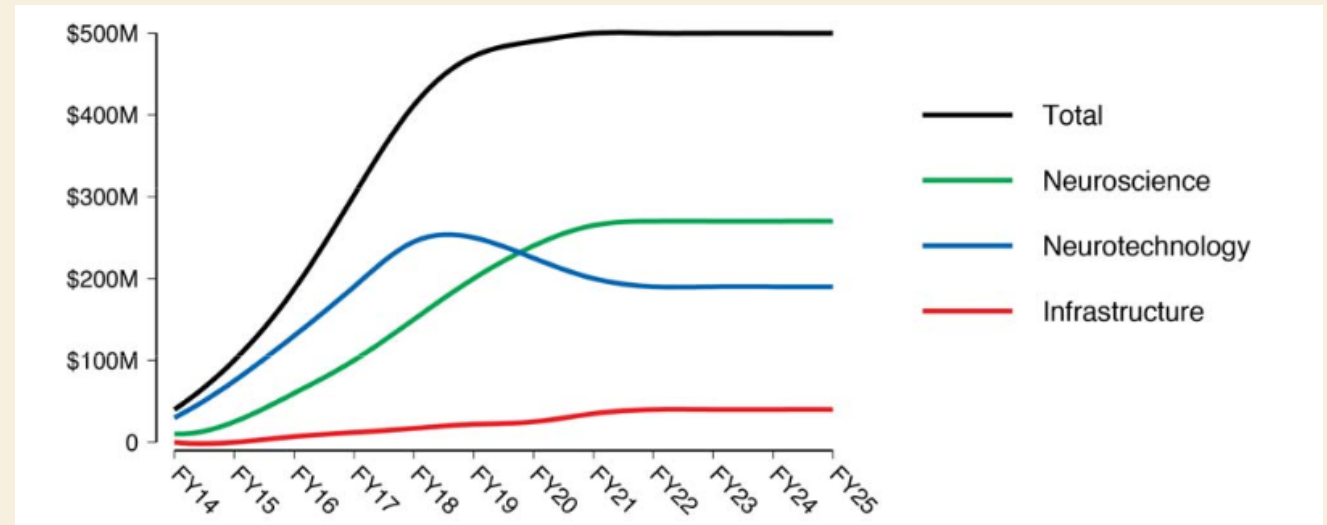
- DBS
- TMS
- tDCS

# METHODS

- Animals
  - In vivo patch clamp
  - Optogenetic
  - Two photon imaging
- Humans
  - fNIRS
  - TMS
  - tDCS

# DOMAINS OF INTEREST

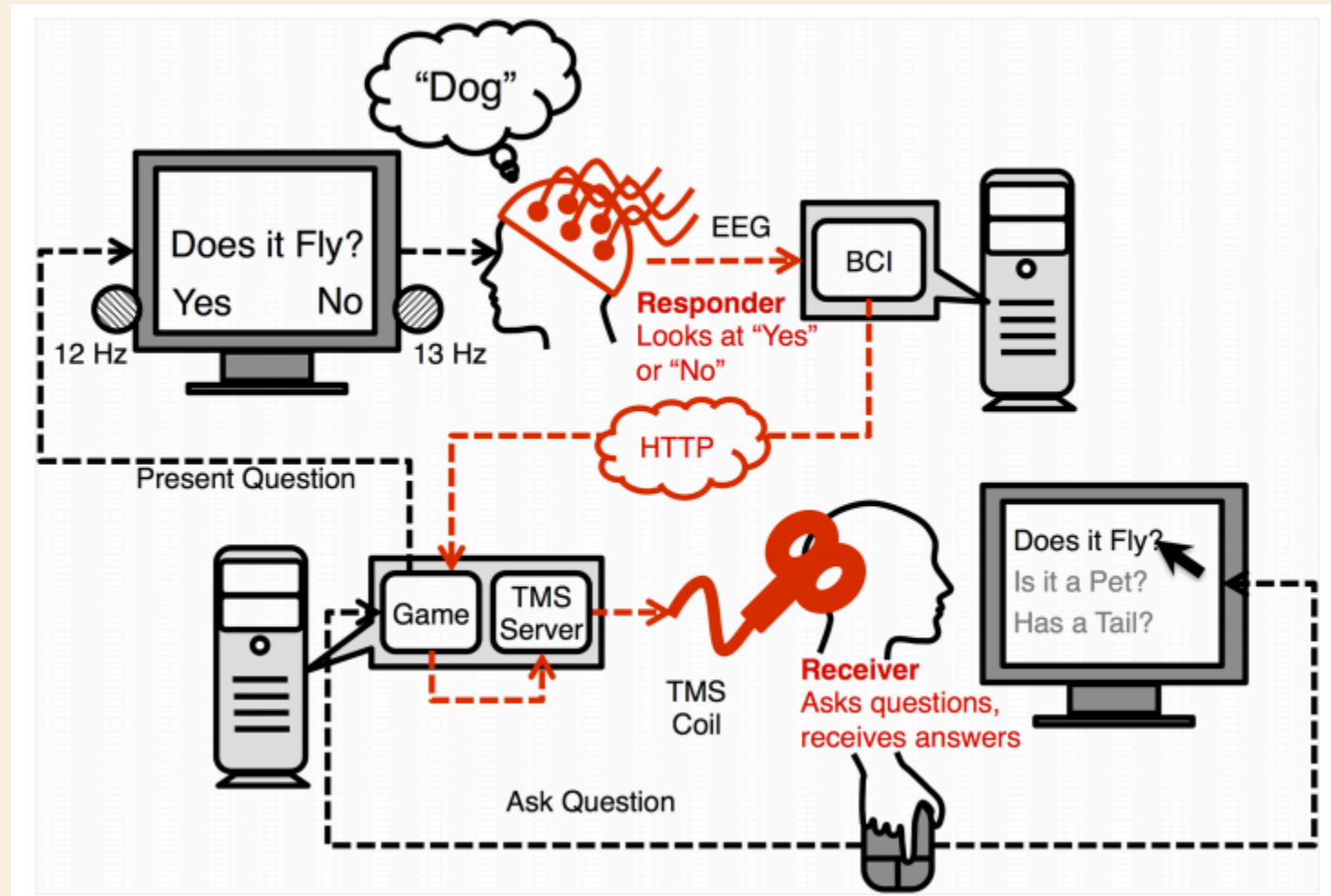
- Neurotechnologies
- Neurorehabilitation
- Translational Neuroscience
- Cognitive Enhancers
  - Chemical
  - Physical
- Neurocomputing - Neuroinformatics



# IMPORTANT FINDINGS

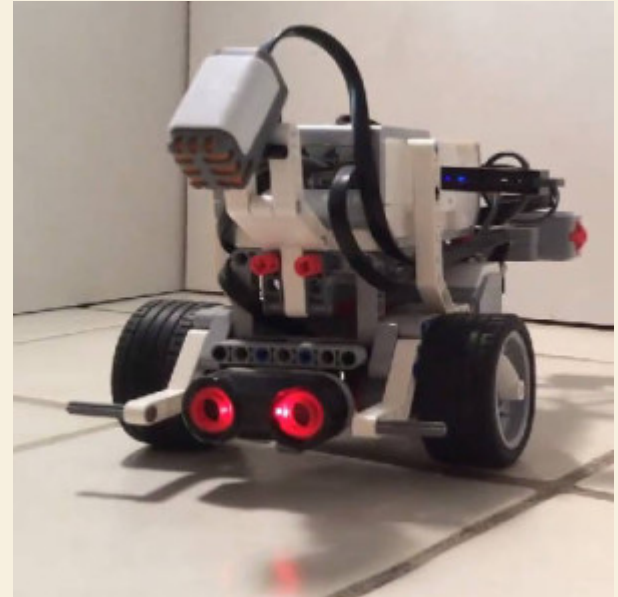
- [Alzheimer's Is Associated with Brain Fungus](#)
- **Brain's GPS earns three neuroscientists a Nobel Prize**

- **The Most Advanced Human Brain-to-Brain Interface Ever Made**

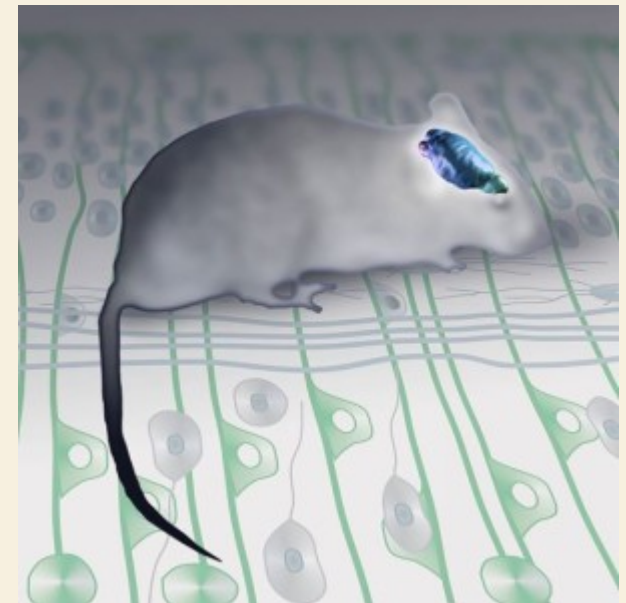




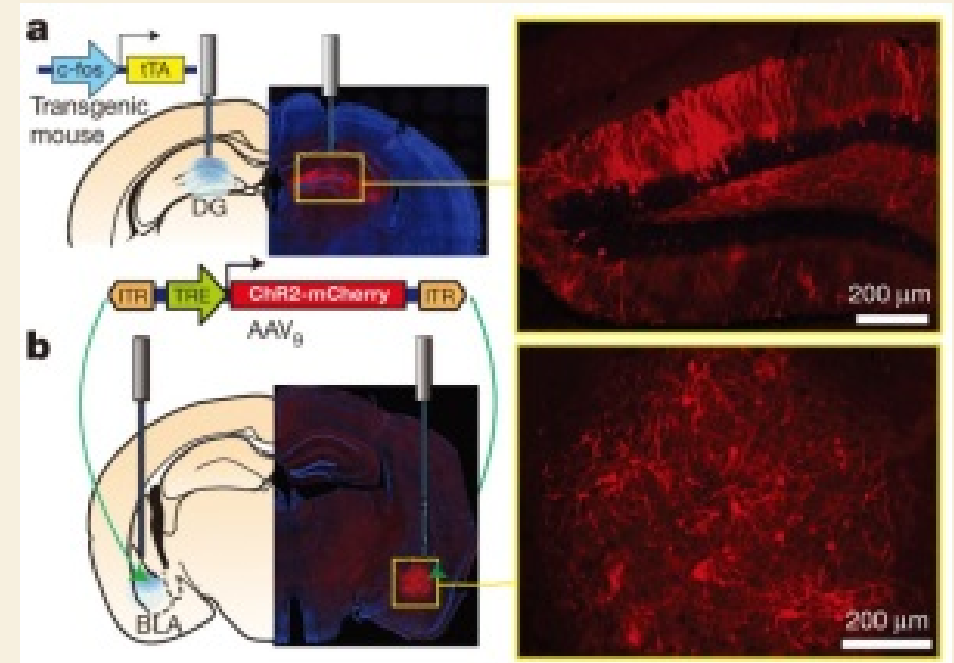
- The Open-Source LEGO Robot Brain



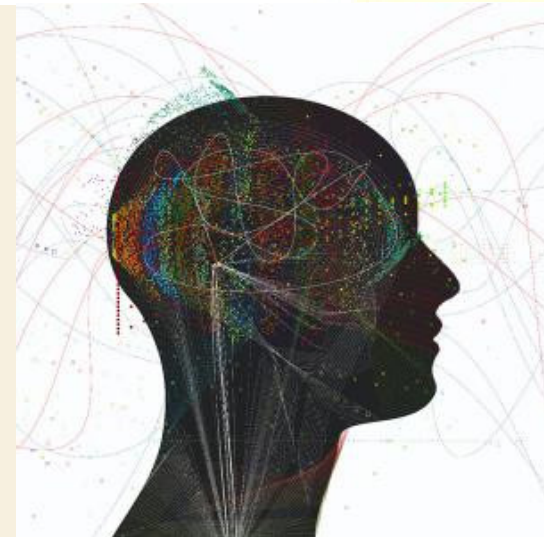
- Super-Brainy Mice



- Copy-Pasted Emotions



- The Consciousness Switch



- **Mind-altering microorganisms: the impact of the gut microbiota on brain and behaviour**
- **Dysfunction of the prefrontal cortex in addiction: neuroimaging findings and clinical implications**
- Genetics and behaviour

# NEUROSCIENCE: INSPIRATION FOR THE MOVIES

- Limitless
- Chappie
- Transcendence
- Lucy
- Matrix
- ....
- ...
- .

# SCHOOL OF ADVANCED TECHNOLOGIES IN MEDICINE

- The only center in the university which hosts all four major areas of new technologies:
  - Nano
  - Bio
  - Information
  - Cognitive

- Thank you 😊