Australian Brain Alliance

CRACK THE BRAIN'S CODE

VISION AND NEUROTECHNOLOGY

How do our brains process sight?

The system that allows us to see accounts for nearly one quarter of our brains. Our eyes take in the information from light reflected by objects, which is focussed on the retina. Light receptor cells in the retina convert the light into electrical signals, which are processed and interpreted by the brain as images. Australian scientists are creating devices to restore vision to the blind, by directly stimulating cells in different parts of this system with information obtained from a camera.

Around one quarter of the brain is involved in some way for vision.

Recent research into how our brains process sight and visual information has revealed that the process is a lot more complex than previously thought. While it has long been known that the brain has two parallel vision pathways, one devoted to motion and the other to recognising objects, a team at Monash University found that the system of brain areas that processes vision acts like a web or network, where many shortcuts and alternate paths are possible. This means that damage to any specific location may be counteracted by reinforcing alternative pathways—a region that is normally used for perceiving motion could be repurposed for seeing shapes. Practical outcomes like this will require further research aimed at finding ways to reshape the neural pathways of the adult brain.

Damage to any specific location may be counteracted by reinforcing alternative pathways.

Bionic Vision Australia (BVA), a Special Research Initiative of the Australian Research Council involving collaboration between the University of Melbourne, UNSW, the Bionics Institute, NICTA and the Centre for Eye Research Australia (CERA), developed a new type of retinal implant to restore vision to people with retinitis pigmentosa and age-related macular degeneration. These devices consist of a small digital camera, a data processing unit and a microchip with stimulating electrodes implanted into the back of the eye. A clinical trial of a prototype retinal implant in three patients in Melbourne proved this technology to be successful. Ongoing commercial and clinical development of the technology will be pursued by the company Bionic Vision Technologies (BVT) with US$18M of venture capital.

While the approach developed by BVA/BVT requires that the optic nerve is still functional, an alternative application developed by researchers from Monash University, in conjunction with Alfred Health, MiniFAB and Grey Innovation also funded under the ARC Special Research Initiative, have developed a bionic vision system to overcome the problems caused by damaged optic nerves for such conditions as glaucoma and traumatic eye injury. This Gennaris bionic vision system involves a camera with a wireless transmitter that sends information to a vision processing unit, which in turn sends the processed data to a series of 9 x 9 mm tiles implanted directly in the vision processing centres of the brain. These tiles turn the data into electrical pulses and stimulate neurons in the visual cortex via an array of penetrating electrodes. This system is currently undergoing preclinical evaluation prior to patient trials.

Future developments are aimed at improving the visual acuity that can be provided by these bionic vision technologies, thereby making it useful for a wider patient population. Improved outcomes for blind patients will come through developing better electrical stimulation technology and tailoring the electrical stimulation to generate more natural responses in the surviving nerve cells in the retina and visual cortex.

This innovative combination of neuroscience, neurotechnology and engineering has the potential to restore some visual ability to many of the people who lose sight as adults.

The Australian Brain Initiative will nurture the basic brain research required to better understand fundamental brain function. It will also progress collaboration between research and industry to advance neurotechnology devices that have the potential to transform not only the capabilities of neuroscience research but also the lives of those living with disorders of the brain and other sensory conditions.

More than 50,000 people in Australia suffer from profound blindness.

50,000

The two most common conditions that cause profound blindness are age-related macular degeneration and retinitis pigmentosa.

M A C
U L A R
D E G E N
E R A T I O N
& R E T I N I T I S
P I G M E N T O S A