HOWARD FLOREY INSTITUTE

MAINTAIN YOUR BRAIN

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The neuroscience revolution: an overview of recent discoveries

Brain and mind disorders cause widespread suffering to individuals, their families, carers, and communities. Indeed, brain disorders cause as much disability as all other causes combined.

These conditions affect young and old. In young people, mood disorders, addiction and schizophrenia rob them of an enjoyable life. Older people are affected by stroke, and neurodegenerative disorders such as Alzheimer's disease, Parkinson's disease, and Motor Neuron Disease. In any one year, over 3 million Australians experience one or more episodes of a major brain or mind disorder.

In addition to the personal, family and community costs of these disorders, the Federal government spends more than $400 million annually on pharmaceutical benefits for mental disorders and nearly $2 billion on disability support pensions.

These costs will rise markedly with our ageing population unless dramatic advances are made in treating and preventing brain and mind disorders.

Fortunately, because of major advances in technologies to investigate the brain, as well as an intense international focus on brain research -- perhaps the last great frontier in science -- it is quite likely that dramatic strides will be made in the next few decades. I would like to discuss five major developments in technology related to brain research that provide this optimism:

1. Perhaps the greatest advance is the human genome project, a magnificent example of international scientific collaboration that was completed well before time and below budget. Knowledge of the complete sequence of the human genome is revolutionising all branches of biology and medicine, but nowhere greater than neuroscience. This is because more than half of the 35,000 odd genes in our genome are expressed exclusively or predominantly in the nervous system. Genomics has given us a royal road into the extremely complicated chemistry of the brain, an area previously very difficult to study.

2. The second example is understanding the brain at the cellular and molecular level. We have approximately 100 billion nerve cells in our brains, nearly 20 times the number of people on earth, and each cell makes about 10,000 connections with other nerve cells. These connections are made at a specialised regions called synapses where special chemicals called neurotransmitters are released to enable communication between nerve cells. The chemical basis of neurotransmission is an Australian discovery by Sir John Eccles team working at the Australian National University in the 1950s and 1960s. We know that learning, memory, and behaviour are all encoded by specialised pathways in the brain defined by the strength of these synaptic connections. In turn, the strength of the synaptic connections is modified by learning and experience. The capability of the brain to modify its function in this way is probably much greater than we had previously thought.

3. The third example is advanced neuroimaging. We not only now have the capability to investigate the anatomy of the living brain in great detail using Magnetic Resonance Imaging (MRI), but can follow the activity of different brain regions while a person is carrying out a task or mental process. This provides a wealth of information on how the normal brain works and on how it malfunctions in disease states.

4. The fourth example is the discovery of neural stem cells in the adult brain. Human embryonic stem cells are very much in the news because of the ethical controversy about their use. However, few people know of the recent discovery of stem cells that reside in the adult brain and may offer new opportunities to repair the damaged brain or spinal cord in the future. We cannot do this at present, but we know the steps that must be taken to get there. They are to study the molecular mechanisms involved in controlling proliferation of stem cells and in regulating their differentiation into specialised nerve cells or supporting cells.

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5. The final example is Alzheimer's disease. I have selected this example for several reasons:

- It is, unfortunately, a common cause of dementia and one that will increase with our ageing population unless we make major breakthroughs
- Exactly 100 years ago Alzheimer described the disease that now bears his name and noted abnormal deposits of a protein called amyloid in the brain. We now know that this abnormal accumulation of amyloid is the cause of the disease.
- Basic neuroscience has worked out in great detail the biochemical pathways involved in formation of the amyloid protein. We can be proud that one of the scientists involved in this pioneering work is an Australian, Professor Colin Masters at the University of Melbourne and the Mental Health Research Institute.
- Based on this fundamental knowledge, and fuelled by the huge resources that academic and research institutions, pharmaceutical companies and biotechnology companies are directing towards solving Alzheimer's disease, it is not unreasonable to predict major progress in the coming decade.
- Perhaps Alzheimer's disease, one of the major scourges of our ageing population, will be the first major brain disorder to be curable or preventable.

In conclusion, brain and mind disorders currently impose the greatest health burden of any disease group. Early intervention strategies are urgently needed. Fortunately the neuroscience revolution now underway offers great promise of developing better treatments and ultimately cures or prevention of these debilitating disorders. Australia can be proud of its world-class research in neuroscience and our scientists are capable of contributing to this revolution, thereby improving the health and wealth of our nation.

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