

## HISTORICAL AND CULTURAL FACTORS CONTRIBUTING TO THE DEVELOPMENT OF THE BIOLOGICAL PERSPECTIVE.

### HISTORY OF BRAIN STUDIES

Early **Egyptians** thought that heart and liver, and not the brain, were the vital organs. However, as early as in the 5<sup>th</sup> century BC **Alcmaeon** stated that brain was “seat of the soul”, with which **Plato** agreed a century later. **Hippocrates** (400 BC) emphasized that the brain was organ of intellect, controlled senses and movement, and that lesion produced a contralateral effect. **Galen** (2<sup>nd</sup> century BC), who was the first experimental physiologist and influenced medical thought for 1000 years, concluded that frontal lobes were the seat of soul.

One of the most important figures in the history of brain studies was the French philosopher René **Descartes** (1596 – 1650). Descartes proposed what at that time was a very new and very radical idea: The human body is an “animal machine” that can be understood scientifically – by discovering natural laws through empirical observation. Descartes argued that human action is a mechanical reflex to environmental stimulation. He proposed that physical energy excites a sense organ. When stimulated, the sense organ transmits the excitation to the brain in the form of “animal spirits”. The brain then transmits the animal spirits to the appropriate set of muscles, setting in motion a reflex response.

In the 1800’s, the basic principles of the nervous system were slowly being unraveled (e.g. **Gall** – working within the phrenology paradigm, he promoted the concept of localization of function, **Helmholtz** – measured speed of conduction nerves). Soon, biologists were approaching an understanding of the details and Descartes’ notion of the reflex got a valid scientific support for example in 1906, when **Sir Ch. Sherrington** discovered that reflexes are composed of direct connections between sensory and motor nerve fibres at the level of the spinal cord. Sherrington also developed the idea that the nervous system involves both excitatory and inhibitory processes (increasing and decreasing neural activity). Also in the beginning of the 20<sup>th</sup> century, **Santiago Ramon y Cajal** detected the physical gaps between adjacent neurons and theorized about the flow of information from one neuron to the next. He proved that the nervous system was composed of individual neurons (Nobel Prize, 1906). Again, Sir Charles Sherrington (British) named what Ramon y Cajal saw: the synapse. Fifty years later, in 1948, **Donald Hebb** used the electron microscope to prove his ideas. He proposed that the brain is not merely a mass of tissue but a highly integrated series of structures, or “cell assemblies”, which perform specific functions.

Researchers in this tradition now call themselves **neuroscientists**. Neuroscientists seek to understand how the brain works, often without removing it from its owner... This would not be possible without the surgical, technological and pharmacological advancements done in the 20<sup>th</sup> century mainly. The techniques researchers use are suited to their level of analysis (cellular, intercellular, behavioral, and social), e.g. interventions in the brain, recording as well as imaging brain activity.

### INTERVENTIONS IN THE BRAIN

Methods involving direct intervention with structures in the brain find their historical roots in circumstances like the story of **Phineas Gage**. At the same time when Gage was convalescing from his injury, **Paul Broca** was studying the brain’s role in language. Broca’s work revealed

the same similar damage to the same area of the brain in the case of speech impairments (known as Broca's area) – e.g. his case study of a man he called “Tan” (he did 8 case studies, altogether). Contemporary researchers still attempt to correlate patterns of behaviour change or impairment with the sites of brain damage.

As the result of lack of control over such case studies, the researchers developed a variety of techniques to produce **lesions**, highly localized injuries in animals' brains. The ethics of such studies has come under heightened scrutiny lately, though. Alternatively, human opportunity samples can be studied. In the process of looking for surgical relief for extreme epilepsy, it was discovered that cutting the corpus callosum of the cerebral cortex greatly improves the patient's condition. **Roger Sperry** was then in his studies able to discover the various differences between the L and R hemisphere.

**Direct electrical stimulation** of the brain of a living person became a fine art in the 1900's. In 1909, **Harvey Cushing** mapped the somatosensory cortex. In 1954, **James Olds**, studying rats, accidentally discovered the so-called 'pleasure centre' of the hypothalamus. In the mid-1950s, **Walter Hess** pioneered the use of electrical stimulation to probe structures deep in the brain. Studying cats, he discovered that, depending on the location of the electrode, sleep, sexual arousal, anxiety, or terror could be provoked by the flick of the switch – and turned off just as abruptly. By the end of the century, the specialized areas of the brain were pretty well-mapped.

The other aspect is attempting to heal people with mental illness. However controversial, the **electroshock therapy (ECT)**, first used by Ugo Cerletti and Lucino Bini in 1938, can be effective in the care of very depressed patients.

Less effective and much more radical is the **lobotomy**, first used on human beings by Antonio Moniz of The Univ. of Lisbon Medical School, who won the Nobel Prize for his work in 1949. The lobotomy was turned into a mass-production technique by Walter Freeman, who performed the first lobotomy in the US in 1936.

TECHNOLOGY AND THE BRAIN – *exploring the brain without removing it from its owner...*

Wilhelm Konrad Roentgen invented the **x-ray** in 1895. In 1972, Godfrey Hounsfield added the computer to the x-ray and developed x-ray computer-assisted tomography – the **CAT** scan, which gives detailed three-dimensional pictures.

In a very different approach, 1929, Hans Berger developed the first **electroencephalogram**. In 1932, Jan F. Tonnesen created the first modern electroencephalogram, with its moving paper and vibrating pens. The EEC records the minute electrical coordinated pulses of large number of neurons on the surface of the cortex. With time, the computer was added to this equation, too.

In 1981, the team of Phelps, Hoffman and TerPogossian developed the first **PET** scan (positron emission tomography). It involves injecting radioactive glucose to the patient's brain, in order to observe the activity of particular parts of brain when performing various mental operations.

In 1937, Isidor I. Rabi noticed that atoms reveal themselves by emitting radio waves after first having been subjected to a powerful magnetic field. He called this nuclear magnetic resonance, or NMR. It was many years later that Dr. Raymond Damadian would recognize the potential of NMR's for medicine. In 1977, he and his students built a prototype of the modern **MRI** – magnetic resonance imaging – which they called the Indomitable.

## THE PSYCHOPHARMACOLOGICAL EXPLOSION

In 1921, Otto Leowi (German) completed the more and more unraveled picture of the nervous system (e.g. Galvani, Helmholtz, Ramon y Cajal, Sherrington) by discovering **acetylcholine** (Ach) and the idea of the neurotransmitter. In 1946, another biologist, von Euler, discovered **norepinephrine**. Next, in 1950, Eugene Roberts and J. Awapara discovered **GABA**.

In the early part of the 1900's, we see the beginnings of **psychopharmacology** as a medical science, with the use of bromide and chloralhydrate as sedatives. Phenobarbital entered the picture in 1912 as the first barbiturate. In the second half of the 1900's, with the basic mechanisms of the synapse understood, progress in the development of psychoactive drugs truly got underway. The progress of psychopharmacology was greatly aided by discovering "internal morphine" or **endorphin**, and the lock-key theory – the basic mechanism of psychoactive drugs – was confirmed.

For example:

- 1949 – **lithium** – lessened the manic aspect of manic-depression (John Cade);
- 1952 – **chlorpromazine** – calming medication (Henri Laborit);
- early 1950's – **imipramine** – the first tricyclic antidepressant (r. Kuhn);
- 1955 – drug **Miltown** – tranquilizer (Frank Berger);
- 1956 – **iproniazid** – an MAOI antidepressant – developed for tuberculosis patients, later banned for side-effects;
- 1961 – **Librium** – sedative (Lowell Randall);
- 1963 – **Valium** – anti-anxiety drug (Leo Sernbach);
- 1974 – **Prozac** – antidepressant (D.T. Wong);
- 1990's – new neuroleptics (antipsychotic drugs) such as **clozapine** were developed, which addressed the problems of schizophrenia more completely than the older drug such as chlorpromazine, and with fewer side-effects.

## GENES AND THE HUMAN GENOME

In 1866, an Austrian monk **Gregor Mendel** published the results of his work, suggesting the existence of "**factors**" – which would later be called genes – that are responsible for the physical characteristics of organisms. In 1910, **Thomas Morgan** discovered that these genes are carried within the structures called **chromosomes**. In 1926, Hermann J. Muller discovered that he could create mutations in **fruit flies** by irradiating them with x-rays.

In 1953, **Watson & Crick** outlined the structure of the **DNA molecule**. The next phase of genetics involves the mapping of the DNA – what is the sequence of bases (A, T, G, and C) that make up the DNA, and how do those sequences relate to proteins and ultimately to the traits of living organisms? In 1977, a **bacteriophage virus** was the first creature to have its genome revealed. In 1998, the genome of the first animal, a roundworm, was published. The year 2000 brought the genomes of the fruit fly and of the first plant. In 2001, the **Human Genome Project** consortium published a draft, claiming to describe some 90% of the human genome, knowing the function of less than 50% of the genes discovered.

Knowing our genetic make-up will allow us to treat genetic illnesses, custom design medicine, correct mutations, more effectively treat and even cure cancer, and more.