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Mind and Brain: From the Egyptians to Cajal and the Neuromyths

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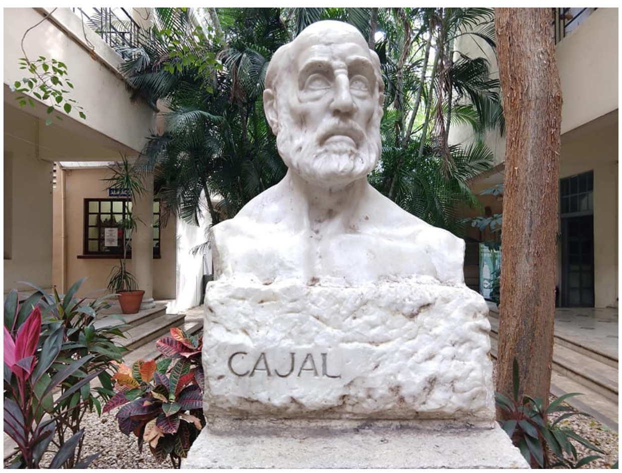
Since the "Father of philosophy", Socrates, and his disciple Plato speculated on the nature of the human mind in the 5th century BC, numerous thinkers such as Descartes (1596–1650), Willis (1621-1675), Locke (1632–1704), Kant (1724–1804), and Freud (1856–1939) have sought to understand human behavior through their observations.[1-3] For René Descartes, the pineal gland, an unpaired structure in the brain, was the physical seat from which the mind could exercise control over the body; the "I think, therefore I am" philosopher thus inaugurated the contemporary mind-body dilemma in the 17th century, pioneering a topic that concerns both physiology and psychology.[2,4] The 17th century English anatomist, Thomas Willis, considered that the corpus callosum was the area where ideas were generated.[3] Willis believed that it was necessary for the rational soul to be accessible to observation and addressed this subject through comparative anatomy of humans and animals, finding that there are many similarities between the brain of man and mammals.[5] Later, well into the 20th century, cognitive psychology and neuroscience merged to give rise to the biological science of the mind, cognitive neuroscience, named after George Miller and Michael Gazzaniga. Miller, cognitive psychologist, first described the limited capacity of human working memory in 7 ± 2 information units; Gazzaniga, neuroscientist, studied the functional lateralization of the brain through the surgical section of the corpus callosum of patients with refractory epilepsy.[1,6,7] As a result, neuroimaging techniques, such as functional magnetic resonance imaging, made possible for the first time to observe mental activity and thus discover what is inside the human brain, making the dream of so many philosophers of yesteryear come true.

Ancient Egyptians placed great value on the preservation of the human body after death; they believed that it would accompany them in the afterlife.[8] In addition, they considered that the source of the emotions, the soul and the intelligence was not in the brain but in the heart, accordingly, when embalming their dead for mummification, the brain was removed through the nostrils and discarded, while other organs, such as the heart, were preserved.[8,9] Embalmers did not attempt to preserve the brain because they believed that it would be replaced by a new one in the afterlife.[8] The *Book of the Dead of ancient Egypt* describes how the deceased pharaoh would be assisted by Osiris, god of resurrection, to replace his head with that of god Atum, creator of the universe, which would be occupied by a new brain.[8,10] As far as is known, Egyptians did not have a real conception of brain function, however, descriptions compatible with neurological diseases such as epilepsy, dementia and cerebral infarction dating from that time are preserved.[9]

The functioning and structure of brain cells were described by Santiago Ramón y Cajal, an Spanish doctor who was the first to describe that the brain is comprised of cells that almost never touch and not by a contiguous network, as his predecessors stated (Figure 1).[11] Cajal, who had painting as his first vocation, perfected existing staining techniques and through a conventional microscope observed and sketched "neural landscapes" for the first time, describing principles whose validity endures to this day: the neuron as an independent cell, its extensions called dendrites that receive impulses, and the distal structure called axon that transmits those impulses to other neurons in order to communicate. Dr. Cajal's descriptions, which constitute the Neuron Doctrine, laid the groundwork to further describe the functioning of the brain.[11]

Figure 1. Bust of Dr. Santiago Ramón y Cajal. Faculty of Medicine of the Autonomous University of Yucatan in Mérida.



The brain of the golden eagle and the human work on these basic physiological principles, but where is the mind in all this? The mind is the virtual entity of the functioning of the brain, analogous to software being a virtual manifestation of the computer. The functioning of the mind is reflected in electrical impulses, neurotransmitters and hormones that neurons use to communicate with each other over small or large distances. Thus, the mind cannot be located in specific parts of our brain, however, it has been stablished that the cerebral cortex and the gray matter neurons inside the brain are necessary elements, although not sufficient, for its constitution.

The human brain weighs an average of 1,500 grams and contains 100,000 million neurons, these being more numerous than the stars in our galaxy.[12] This complex system is made up of multiple interconnected parts that — when self-organized into a single system — manifest one or more emergent properties strikingly different from any of the properties of the individual components.[6] Emergent properties are a common phenomenon accepted by many fields of knowledge, such as physics, biology, chemistry, and sociology.[6] In neuroscience, a clear example is consciousness, which arises from the collective activity of a large number of neurons:[13] focusing on the individual firing of a neuron at the cellular level may not tell us everything we need to know to understand it.[6]

Distinguished thinkers such as Eric Kandel, Nobel laureate in medicine, state that the 21st century will be marked by discoveries in the biology of the mind, just as the 20th century was by Watson and Crick's biology of the gene.[14] The discovery of the DNA helix laid the foundation for understanding how hereditary information was transmitted and combined between individuals; the milestone that crowned the investigation of the genetic code was the Human Genome Project, which consisted of identifying and locating the genes of the human species by analyzing the DNA of hundreds of people.[15] In 2003, it was possible to identify that human beings have between 20,000 and 22,500 different genes.[15,16] Similarly, the Neuron Doctrine of Santiago Ramón y Cajal established the basic principles of the International Human Connectome Project that aims to identify the structural and functional connections of neurons through methods such as functional magnetic resonance imaging and electroencephalography; it is evident that the study of the Human Connectome is more complex and gradual than the Human Genome Project.[17] Although the brain is the product of our genes and all human beings share 99% of our identical DNA, the particular experiences of each individual influence variations in brain networks; this is confirmed in identical twins who, even when they share 100% of genetic material, do not have the exact same brains.[17,18]

The popularization of neuroscience to the general public has its risks and can lead to misunderstandings, since it is often difficult to explain and convey all the subtleties of scientific discoveries. When brain science is linked to other areas such as education, misconceptions, called "neuromyths", may arise.[19,20] The most widespread neuromyth, among teachers, general population and people highly exposed to neuroscience, is the one of "learning styles", which states that people learn better when they receive information in their preferred learning style: auditory, visual or kinesthetic.[19-21] Although there are areas in the brain specific for auditory, visual and motor information processing, all are interconnected: studies have shown that there is no better learning with techniques focused on a particular style, but, on the contrary, learning is limited.[19,20] When working simultaneously with these three "styles" learning is more significant, that is, it is associated with more memories. This is just one example of a neuromyth — a false scientific belief about neuroscience applied to learning —, however, there are many more and all of them often have a misinterpreted scientific foundation.[19,20] Another popular neuromyth upholds that left or right hemispheric brain dominance helps to explain differences between students, establishing that some are more creative and others more analytical.[19-22] This theory posits that personality, behavior, and abilities in individuals are governed by a cerebral hemisphere.[19-22] Although it is true that the hemispheres are specialized in different tasks (lateralization), their connection through the corpus callosum makes them work together, in addition, neuroimaging data have not provided clear evidence of phenotypic differences in the strength of left-dominant or right-dominant networks.[22]

These 1,500 grams of brain matter is all we are, because without memory we would not be ourselves: everything we love is in the brain, everyone we know is there, our joys and sorrows, science and art, all our knowledge. Since ancient times, every philosopher, every hunter and gatherer, every king and commoner who ever lived has seen the world and the universe through their brain. Nothing that is human is alien to us through neuroscience.

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