EDITORIAL

THE FASCINATING HUMAN BRAIN: FROM DEVELOPING NEURON TO ARTIFICIAL INTELLIGENCE

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The brain is most probably the most investigated and less known organ of the human body. Based on new technologies and molecular methods introduced in the research practice in the last decades, new characteristics and functions of the brain have been deciphered, and some old dogmas were refined or even denied. We do not know a lot of things about the brain, and moreover, we get no answer to some very simple questions, like how many neurons does the brain contain, which is the real rate between neurons and supporting cells, or what are doing the neurons in some specific locations? Anyway, it seems that 75 to 89% of human neurons are incompletely characterized. They work, but what are they really doing there?

There are many myths and misinterpretation about the brain, usually described as "facts". In the last 15 years there were accumulated many data that support our understanding of both structure and functions of the brain. Data continue to change, as significant modifications occur due to increasing stress or/and almost permanent exposure to electromagnetic waves that affect more than 140 proteins from the brain.

In this number of Research and Clinical Medicine, Ciurea et al (1) dissected with accuracy of a neurosurgeon some basic aspects of the brain in normal and pathological conditions, including neurogenesis and neural plasticity. On one hand, it is an up-to-date, on the other, it is a challenge and an invitation for clinicians and researchers to go deeper and deeper in the study of the brain on a pathway opened hundreds of years ago, by scientists as Hippocrates, Varolio, Broca, Waldeyer, Cajal, and many others.

Based on results coming from experimental models, the existence of some cells involved in maintaining the neural cell population has been suspected in birds and rodents many years ago. In human, only the replacement of olfactory neurons was well documented, but without an explanation for the source of newly-formed bipolar neurons. By January 1st, 1999, Jonas Frisen and colleagues at Karolinska, announced the discovery of human neural stem cell (2. 3). It was a turning point in the researchers on brain biology and it has been shown that these cells are located in some specific anatomic sites. More important, neural stem cells can give rise in the adult human to new mature neurons during lifetime. Nowadays, the human and animal neural stem cells are well characterized, they were isolated, and cell lines are commercially available for experimental purposes. Therefore, it seems true that already differentiated neurons do no longer undergo division, but if damaged, they can be replaced in certain conditions governed particularly by the microenvironment. Anyway, this discovery opened a broad field in research in both basic knowledge and clinical application (particularly there is a hope in trauma of the spinal cord, or using neural stem cells as vector for drug delivery in brain tumors).

To know more about the structure of individual cells of the brain is equally important. But techniques used to investigate the fine structure of the brain are significantly more sophisticated than for any other organ. This is particularly true in evaluating microscopic features, performing immunohistochemistry, molecular profile, or gene analysis. To be even more difficult, many neurotransmitters working in the brain are small molecules, some involved in learning and memory, not easy to detect because their short half-life. From here there were generated a significant number of confusing and controversial results about the functioning of the brain. This is why it is important to know the structure in order to understand the functions, as Cosma et al (4) did for Purkinje neuron of the cerebellum in this number of the journal. As already mentioned, it is essential to understand and to demonstrate the function of the microscopic detail. In respect to this, we need to remember what Albert Szent Gyorgy said: "Structure and function are two sides of the same coin. If they do not match, we did not look carefully at minimum one of them".

More than 10.000 different types of neurons are found only in the human brain. By far, much more than the types of cells from any other normal tissue or organ. Most of them are known from more than 100 years and were almost exactly described in the seminal work of Santiago Ramon y Cajal (5). Why such a diversity? This might explain the extraordinary diversity of human brain functions, and virtually create an unlimited field for learning, memory, imagination, emotions, analysis, and so on. This is possible because each neuron is interconnected with many others that stimulate, re-model or/and inhibit the original response to a stimulus, or, more frequent, to a combination of stimuli. Starting from the known architecture of the brain, it was born

the idea to generate neural networks, an important step toward artificial intelligence.

Neural networks are computational systems, created for the first time in 1943 by McCullock and Pitts (6), in part inspired by the network of neuronal processes, axons and dendrites. Although a lot of progresses were made in the next decades, even today the neural networks do not include a component similar to supporting cells. The existing neural networks can learn to recognize images based on the analysis with the existing in the database. A neural network is not difficult to understand if you know the mathematical model behind it. A single neuron is the most fundamental component of the neural network. Like natural neurons, components of the network perform connections, also called artificial synapses that can transmit the information. As the work in the field progressed, deep neural networks have been developed. Although still far from the performances of the human brain, it was an important toll to generate artificial intelligence.

What artificial intelligence does really mean? Artificial intelligence defines the intelligence of machines and it was founded as academic discipline in 1956. Artificial intelligence has a broad spectrum of application, virtually in all fields of our life. In many instances, it is a reality, not a promise or hope. Bus without driver, learning without teacher, are only two examples of artificial intelligence reality, and not a science fiction movie. Which is the impact of artificial intelligence in medicine? Yesterday (January 1st, 2020), The Guardian published an article about an artificial intelligence system able to detect breast cancer better in mammograms than doctors which are experts in radiology and imaging (7). It is expected that artificial intelligence will be a part of our medical life sooner than we believe. This means that the brain and the nervous cells were investigated very well until now...

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