Journal of Neuro Psychiatry Reports

Short Communication

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Informational Neurophysiology: Declaring The Launch of a New Topic in Brain Functionality Studies

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Received: December 20, 2024; **Accepted:** December 23, 2024; **Published:** December 31, 2024

Informational Neurophysiology is a new branch of neuroscience aimed at studying the mechanisms of brain working. In essence, it is a modernization of traditional neurophysiology, which in itself is a field of physiology that deals with the functions of the nervous system.

Historically, neurophysiology has been dominated by **electrophysiology** – the electrical recordings of neural signals that accompany the interaction and communication of neurons.

The recordings unanimously confirm that the functional activity of the brain is expressed in the transmission of electrical impulses between neurons.

What is actually transmitted by these impulses? – the question has never been even asked. The answer was clear and self-obvious: **information is what is being transmitted in neural communications.** (This was the soul and spirit of Shannon's view of information, as presented in his famous article, "A Mathematical Theory of Communication," University of Illinois Press, 1948.)

From this understanding (of electrical impulses as the means of neural communication) follows the well-known and commonly accepted dictum, **"brain is processing information."**

However, by the end of the last century it suddenly became clear that there are other ways of transmitting information (by neurons), not electrical impulses, but a whole set of chemical compositions and structures called **neurotransmitters.**

Such divergence in forms of information transmission can be explained by only one thing – in modern biology there is no a correct **definition of what information** is.

(In his fundamental article, **Shannon did not define "what is information"**. Shannon (and other founding fathers of information theory) came up with and used a substitute for information – the concept of "**information measure**". Using it, they achieved remarkable success in improving the means of technical information communication. Not biological information communication. Not biological (neural) exchange of messages.

To get out of this impasse, I proposed (many years ago) my own definition of information, which today sounds like this: **information is a linguistic description of data structures visible in a given data set**.

The implications of this definition for biological (neural) information are fascinating and impressive. Let me mention just a few of them:

The visible structures observed in a given data set can be divided into two types – simple primary data structures and complex secondary data structures (structures of structures). Accordingly, their descriptions will be called **primary and secondary information descriptions**. In other words – primary and secondary information. Or in a slightly different form – **physical and semantic information.**

This division of information is new and quite unusual in contemporary sciences. (Shannon even refused to recognize semantic information as part of the information communication process). Accordingly, information processing should also be divided into physical information processing and semantic information processing.

In biological (neural) systems, they are performed hierarchically, i.e. physical information processing works on input data, and semantic information processing works on subsequent fragments of text, which are the output of any stage of processing.

It should also be mentioned that physical and semantic methods of information processing perform at two different levels – physical information processing acts at the level of input data, i.e. it has an objective nature, while semantic information processing has a subjective nature, because it is determined by the observer's experience and habits.

Therefore, the creation of texts of a higher level of complexity at each subsequent stage of processing is not a predetermined, natural process, but a subjective process which requires prototyping, i.e. references or examples that are usually stored in the system's memory (in the neuron's memory).

This division between physical and semantic information is new to almost all information processing implements – they all are busy with processing physical information (i.e., they are data-driven processors), while the brain is busy with semantic information processing (i.e., it is a text-driven processor).

In this regard, another novelty should be mentioned – information descriptions are written in letters of the biological alphabet, i.e.

nucleotide letters and amino acid signs. This makes information descriptions physical objects with their length, weight, volume and other physical parameters. The material nature of information requires special spatial volumes for its placement and storage (for example, for storing prototypes of semantic information).

This leads to a new understanding of the function of the known physical elements of the neuron - synaptic spines (for storing filtering samples of the signal), or the myelin sheaths of the axon (serving to store prototypes of epigenetic information, and not to accelerate the passage of electrical impulses, as it is commonly seen in electro-neurophysiology).

Finally – for almost a century, electrophysiological principles of modeling brain functions have been a hot topic in modern neuroscience and its derivative – modern neurophysiology.

The purpose of this article was to convince the reader that the time of **electro-neurophysiology** has passed and it must be replaced by **informational neurophysiology**.

Although the purpose of this article was to draw readers' attention to the importance of the issues of information communication and information processing in the study of nerve cells physiology, it must be categorically stated that all cells in living beings are certainly dependent on how information is communicated and processed during intercellular interactions and normal functioning of the cells system.

This article briefly outlines the basic principles of informational neurophysiology.