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Stimulation of the educational process in synaptic plasticity

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Abstract: *The work presents a discussion about the relationship between neuroscience and education, being specific in the treatment of the stimulus of the educational process in synaptic plasticity. We introduce with the history and definition of neuroscience, sequencing in relation to education and ending with synaptic plasticity through the stimulus of teaching. We emphasize the importance of research in this multidisciplinary relationship, presenting in the educational context the functioning of the brain and the factors of an important dynamic for the teacher to stimulate the synapse, being effective in the student's learning.*

Keywords: plasticity; synapse; educational; stimulus; neuroscience; apprenticeship.

1. Introduction

Several studies seek to make a connection between neuroscience and education, raising questions about how learning and the process take place, through the discussion of the detailed study of the brain, in particular, the synapse. The idea of this work is to understand this change of the synapse caused by the external stimulus of the educational factor.

Researchers seek to understand this physiological change, contributing to this interdisciplinarity to obtain favorable mechanisms not only for student learning, but to better understand the functioning of the brain through the assimilation of new content and the effectiveness of the educational process.

Due to the complexity of the education factor and its processes, with difficulty in conducting this connection between the two sciences, this work aims to present the guiding question of the relationship between neuroplasticity and the stimulus caused by education, through the understanding of brain productions.

We will briefly discuss the historical basis and definition of neuroscience, following its relationship with learning and ending with the synaptic plasticity stimulated by teaching.

The study is of a bibliographic nature, aiming to expand the knowledge about the functioning of the brain and the contribution that education can provide in this relationship, since learning involves directly activating the mechanism of the nervous system.

2. History and Definition of Neuroscience

Studies on the sensory function of the brain were carried out by the Greek Alcmaeon of the Pythagorean school of Croton around 500 B.C., for the discovery of brain function. The Dutch physician Herman Boerhaave (1668-1738), a pioneer in the subject with studies of neurology, published *morbis nervous* in 1735 [1]

The term neuroscience was developed by neurophysiologist Ralph Waldo Gerard of the University of Chicago in the 1950s. Although Gerard coined this term, it was disseminated in the 1960s by biophysicist Francis Schmitt, head of the Department of Biology at the Massachusetts Institute of Technology (MIT), where he referred to the interdisciplinary field of knowledge, with the nervous system as its object of study.

At that time, Schmitt coordinated research to understand the functioning of the brain and the control in the relationship between behavior and the human mind. It brought together specialists from different areas, interested in discovering its mechanism, because through this experience with different professionals in training, they would contribute to the process of interdisciplinarity by the search for explanations about the mechanism of learning, memory, movement control, emotions, and human behavior [2].

The United Nations Educational, Scientific and Cultural Organization (UNESCO) has referred to neuroscience as the study of the biology of the nervous system and human, social and exact sciences and this interdisciplinarity makes it improve the quality of life [3].

Neuroscience involves several areas, but it specifically studies the nervous system involving these areas. Neuroscience is divided into five forms of studies, relating physiology and the nervous system, having as the diversity of models that nature offers, which is the animal spectrum, the effect of drugs on the nervous system, the stages of development and aging, various pathologies, and consequences of injuries in their functions, the study of the mind with intelligence, cognitive ability, and behavior.

For the study of problems of the mind and brain, there are two fundamental strategies, being the study of nervous function and its alterations of speech, sleep, intellect, consciousness, delirium, organic regulation and disorders of sensation and pain, spasms, incontinence, gait, posture and

paralysis. The other strategy is connected to the etiological study of pathologies of the nervous system, such as neoplasms (tumors and cysts), neuroendocrine and nutritional diseases, mental disorders and behavioral disorders, degenerative diseases, trauma to the central and peripheral nervous system, ischemia, infarctions, and hemorrhages [1].

3. NEUROSCIENCE OF LEARNING

Neuroscience and Education are distinct fields, as the former is focused on the biomedical area and the latter on the school area. The main object of study in neuroscience is the central nervous system, especially the brain. In the case of education, the object of study is learning and what is currently sought to be studied as an object of study involves the relationship between the brain and learning [4].

Education has always been a field of discussion, due to the sensitivity in relation to educational work with young people in preparation for both the job market and the research sector, which configures a scenario always open to debates so that the teaching-learning process has more and more consistency and meets the demands of social reality.

Therefore, education that incorporates learning should understand that students achieve knowledge, through strategies and mental conditions, starting in the family, going through the historical and cultural factor, being improved in the school environment, and should use methodologies that value skills, knowledge, and competencies [5].

Within this reality, the act of learning involves factors such as context, method, object of study and the individual, because:

> Different theories of learning have elaborated different ways of understanding the seemingly simple dynamics that occur between subject, object, context, and method. To understand human learning, it must be considered fundamental to understand that it results from the understanding of each of these elements that make up the epistemology of the learning act [6].

The evolution of the student in learning starts from the stability of the evolutionary follow-up of the mind, by experiences accumulated throughout life, as well as by social interaction because:

> Learning is a process that begins from the confrontation between objective reality and the different meanings that each person constructs about this reality, considering individual experiences and existing social rules [7].

Learning involves the acquisition of new information and the nervous system, involved in receiving, transmitting, analyzing, organizing, and triggering responses, in the external and internal form, consists of a complex network to coordinate and control all the systems of the organism, responding appropriately to the stimuli received [8].

John Bruer called it the "argument of neuroscience and education" in his studies, awakening the scientific community. In the 90s, many teachers were interested in studying and publishing this relationship between neuroscience and education, due to the possibility of revolutionizing educational practice in the understanding of brain development and neural functions. The argument called by Bruer was based on three findings of developmental neurobiology, leading to hasty interpretations and conclusions on the part of teachers, due to the great interest for direct application in the classroom.

The first finding was the occurrence of a dramatic increase in the number of synapses followed by a period of synaptic elimination during the infantile stage. The second discovery was due to the existence of critical periods, being dependent on experiences in the development of sensory and motor systems. The third discovery carried out experimentally in mice is that in complex or enriched environments they cause new synapses to form. Bruer considers it important to be careful with the use of data from these findings for educational application, as they still lack reliable information, such as the relationship between synaptogenesis and the acquisition of reading and arithmetic skills, acquired through social and school interaction.

Bruer considers that there is a bridge between Educational Practice and Cognitive Psychology and another bridge between Cognitive Psychology and Cognitive Neuroscience. This relationship is important to verify how the study of the brain can contribute to educational practices [9].

Several contributions have been made to the treatment of neuroscience in the educational field, because as this interdisciplinary relationship seeks to study how the brain learns, we have a vast field in the search for understanding the constitution of neural networks in the learning period, establishing memories, storing information, and approaching stimuli to the brain [1].

Mietto believes that [10]:

> Neuroscience comes to unveil what we previously did not know about the moment of learning. The brain, that fantastic and mysterious organ, is a matrix in this process of learning. Its regions, lobes, grooves, recesses have their function and real importance in a joint work, where each one needs and interacts with the other [10].

The idea behind the discussion is about the complex process that results in structural and functional modifications

of the central nervous system. In the case of learning, it involves memory and for Relvas: "*it is the mental reproduction of the experiences captured by the body through movements and senses. It is also the capacity for planning, abstraction, judgment, criticism and attention*." To engage in this discussion, it is necessary to study memory, learning and synapse [11].

4. Synaptic Plasticity Stimulated by Teaching

Brain malleability, also known as neuronal plasticity, is the continuous conditioning of the structure and functions of the nervous system in the face of various stimuli. It is a natural and fundamental process for the development of memory, being where stimuli are caused by events experienced, such as receiving information or injury. Scientifically, there is evidence of neuroplasticity conditioning, such as experiments carried out with violinists, finding an increase in the cortical area of the fingers and left hand, to raise the neck of the violin, confirming that the continued use of the instrument increases the representation of the area [12].

Within the nervous system there is an organization of functions and activities, with billions of nerve cells, allowing the human being to have the ability to act, feel and think properly, being called a network of connections. Plasticity involves this network of synaptic connections between neurons and glial or sustaining cells.

Neurons are nerve cells connected to each other in the communication of functions, where the axon which is the long-span neuron transmits electrical signals at its end, releasing neurotransmitters through a synapse to the dendrite of an adjacent neuron [13].

Glial cells, on the other hand, are essentially neural progenitors, intermediating the transfer of nutritive substances to neurons, as well as maintaining vascular tone by the synthesis and secretion of vasoactive molecules [14].

As for the typology of neuroplasticity, we have the somatic one that regulates the disuse, proliferation and death of the nerve cells present in the nervous system of the embryo, the axon that goes from birth to two years of age, being fundamental for the development of the healthy nervous system, the synaptic one that relates the exchange and conduction of information through internal and external stimuli, the dendritic one occurs by the alterations of the dendritic spines in terms of disposition, density, length and number, forming new neural circuits and the regenerative one that restores the injured axons, commonly in the peripheral nervous system, where inactive synapses function soon after the injury when stimulated [15].

All this interaction will occur through the stimulus. In the case of the learning process, the more the student does school exercises, reading, researching the subjects dealt with in the classroom, the more this student strengthens the synapses, solving the issues discussed, decoding the new information absorbed by the student in the transmission, originating learning.

In the specific case of the relationship between the synapse and the learning process, it characterizes the student in a continuous development of the assimilation of knowledge. This adaptation of the nervous system makes the student question and reflect, having the ability to interact, sharing ideas, being known, as a mechanism of higher cognitive functions, where in general, neuronal plasticity produces learning, but when stimulated, being internal carried by genetics and external by the environment and experiences [16].

For Relvas [17] the learning is not so simple, going beyond the transmission of information. He believes that the educational stimulus must be solid to have modifications, new adaptations, cognitive, affective, and motor, where he asks:

> Is there a bridge between the understandings of science and education? Efforts are needed to understand how one learns, having as the main process the interrelationship of the nervous system, mental brain functions and the environment. Therefore, the question is to provoke in the educational sciences this possibility that learning and behavior begin in the brain and are mediated by neurochemical processes. This way found in this dialogue, for a more neuroscientific Pedagogy, understanding that human brains are different through their processing and procedures, and that Neuroscience is, thus, a set of disciplines that study by the most varied methods, the nervous system and the relationship between brain and mental functions.[17]

Obviously, it is not an easy task for the teacher to develop aspects that identify in the student, about the feeling of seeking and wanting to learn. When educational activities provoke curiosity and make it reflective, the teacher has certainly partially achieved the learning objective. If there is no such proposal, only a relationship of information transmission will be established, with no decoding and internalization by the student, because the stimuli were insufficient to cause a positive impact on learning [16].

The complexity in the learning process is due to the time that the brain has to decode and encode the information, where depending on the work that the teacher will do in the classroom, he will be able to make the stimulus change the synapses.

Lent raises interesting questions about the relationship between learning and emotions, considering the student's past and the present moment experienced by him, emphasizing the importance of the limbic system, which is responsible for

emotions and behaviors, where his neurons receive stimuli and conduct information. In general, if the student is not feeling well physically or psychologically, it will hinder their ability to learn [15].

The learning process will depend on the stimulus, because:

> Neuroscience, when it dialogues with Education, promotes ways for the teacher to become a mediator of how to teach with quality, through pedagogical resources that stimulate the student to think about thinking. However, it becomes essential for the teacher to promote the correct stimuli at the right time so that the student can integrate, associate, and understand. These stimuli, when framed and applied in everyday life, can be transformed into meaningful and pleasurable learning in the school process [18].

The importance is not in the quantity, but in the quality of the stimulus. It is important for the teacher to use a variety of methods to favor the quality and effectiveness of learning, consolidating learning through focus, organization, and neural rhythm [17].

It is necessary that the classes are more dynamic, with a closer dialogue with the student, as it allows a greater involvement of the student with the subjects covered, use of methodologies so that the student can, thinking, questioning, providing moments of relaxation and exchange of knowledge, reducing traditional mechanistic activities and according to Costa:

> Proximity to students can contribute efficiently to coexistence within the classroom. If this closeness comes from the teacher in constituting a relationship of affection and affection, he will be able to observe an efficient channel that provides opportunities for new horizons between the knowledge and learning of the teacher and his students [19].

The teacher's adequate pedagogical tools will cause transformations in the quantity and quality of synaptic linkages, causing satisfactory brain functioning. For example, classroom activities involving computing, simulation and games certainly place the student in the condition of protagonist, having an active participation in the construction of knowledge and that for Mietto considers that:

> The content that used to be discouraging and repetitive for the student and teacher takes on a new look: it now provides new discoveries, new knowledge, is dynamic and flexible, plugged into a computerized era where at every moment new information reaches the student's world. Teacher and student interact actively, create, enable possibilities, and means of doing this knowledge, building learning together [10].

The student needs to understand their role in society and through this dynamic interaction in the classroom, stimulates the desire to learn, research, being active in the learning process.

In any case, neuroscience deals with the internal factor of learning and education deals with the external factor, being the result of interventions in the teaching process and the teacher connecting the two sciences, makes the synapse establish, as the brain produces what is stimulated in the classroom, resulting in learning [4].

5. Final Considerations

We understand that neuronal plasticity is the continuous conditioning of the structure and functions of the nervous system in the face of various stimuli and that the conditioning of neuroplasticity increases the cortical area due to the continuous practice of a certain activity. The cells within the nervous system allow the human being the ability to think, act and feel properly, being known as the network of connections, where plasticity involves this network of synaptic connections between neurons and glial or support cells.

The relationship of the synapse with the learning process makes the student continuously assimilate his knowledge, through adaptations, leading to questioning, improvement in argumentation and repertoire, conditioning to interact, sharing ideas, being known, as a mechanism of higher cognitive functions and in general, neuronal plasticity produces learning when stimulated, being internally charged by genetics and the external by the environment and experiences.

Everything makes us believe that it is important to study the potential of the synapse and how we can improve pedagogical activities to stimulate to make a significant impact. We understand that neuroscience investigates several areas and one of them fits perfectly in the relationship of the educational field. The contribution is necessary and important for teachers to build a solid educational process for student learning.

The knowledge of neuroscience on the part of the school and teachers on the understanding of the nervous system, broadens the horizons not only discussing the external factor of the human being, but also internal and based on neuroscience, the teacher understands the importance of working in the classroom, activities that allow the student to develop reflective thinking, stimulating the ability to deepen the concepts through research work, simulations, use of technology, learning that is meaningful, as it will strengthen the neural networks where they are sensitive to the effectiveness of learning.

6. REFERENCES

The template will number citations consecutively within brackets [1]. The sentence punctuation follows the bracket [2]. Refer simply to the reference number, as in [3]—do not use "Ref. [3

For papers published in translation journals, please give the English citation first, followed by the original foreign-language citation [6].

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