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SYNAPSES: ELECTRICAL OR CHEMICAL, WHAT FOR?

Abstract: The human nervous system produces amazing phenomena such as memory, perception, thinking and language. It also directs actions or interprets messages received by the senses. It consists of about 100 billion nerve cells, also called neurons. All brain activity results from the interaction of these neurons with each other. And it is the synapse, that is, the area between two nerve cells, that provides the transmission of information between these two nerve cells. Thus, a synapse is a histological structure that connects the axon of one neuron with the dendrites of another neuron. The synapse is the site of transmission of nerve impulses due to the intervention of a mediator such as acetylcholine or noradrenaline. Various works during the 20th century showed that there are two types of synapses, electrical and chemical, and later electron microscopy made it possible to prove that these two types are very different from each other.

Key words: Anatomy of synapse, physiology of synapse, chemical synapse , Anatomy of the synapse

A synapse is a junction between two neurons (also called nerve cells). This zone, located between two neurons, ensures the transmission of information from one to the other. Etymologically derived from the Greek word synapsis, meaning junction, the synapse is therefore an important link in the central nervous system of humans, as well as of all mammals. This central nervous system in humans consists of the brain and is divided into two hemispheres, the right hemisphere and the left hemisphere are separated from each other by the median groove, which is narrow but very deep. The central nervous system is based on well-defined synaptic circuits. These circuits are established during brain development: they are based on the billions of connections established between neurons and synapses.

A neuron consists of a cell body called the soma, from which several extensions called dendrites or axons extend, depending on the direction of propagation of the nerve impulse. Thus, in the dendrite, the nerve impulse spreads towards the soma, and in the axon, it goes out. Basically, an axon carries information from a neuron to other neurons in the brain or to muscle fibers outside the brain. Finally, a synapse is where the end of an axon makes

contact with another neuron or muscle fiber. In a neuron, many synaptic boutons are attached not only to the cell body of the neuron, but also to the dendritic branches.

A presynaptic neuron is upstream of a synapse, and a postsynaptic neuron is downstream. It is a presynaptic neuron that acts on the postsynaptic by releasing a substance called neurotransmitter, such as acetylcholine or norepinephrine, through the synapse . A postsynaptic neuron combines the messages received by its synapses, synthesizes them every minute, and outputs the message it sent.

PHYSIOLOGY OF THE SYNAPSE

There are chemical synapses, which are connected by molecules called neurotransmitters, as well as electrical synapses.

CHEMICAL SYNAPSES

Synapses that use a neurotransmitter, also called a neurotransmitter, are chemical synapses (or most synapses). This chemical molecule is actually a messenger. It accumulates in vesicles located at the end of the axon of a presynaptic neuron (called the presynaptic terminal). When a nerve impulse arrives (called an action potential), the neurotransmitter is released into the synaptic space: "bundles" of molecules are then released at the synapse.

This phenomenon is associated with a large influx of calcium, which causes a series of chemical reactions, as a result of which a certain amount of neurotransmitter is released. Thus, these neurotransmitters cross the synapse (or synaptic gap) and they attach to special receptors located on the postsynaptic neuron or effector cell. The binding of a neurotransmitter molecule to its receptor causes hyper or depolarization of the postsynaptic cell. In a chemical synapse, the transmission of information is necessarily directed from the presynaptic element to the postsynaptic element.

About a hundred chemical molecules are now known for their role as neurotransmitters. The smallest are monoamines such as dopamine, adrenaline or even serotonin. The largest are proteins, which can contain several dozen amino acids. Not all of these neurotransmitters are present in the same synapse. On the other hand, the simultaneous coexistence of several neurotransmitters probably explains the great subtlety in cellular communication processes.

ELECTRICAL SYNAPSES

Electrical synapses are often concentrated in zones that allow the rhythmic coordination of the activity of a group of neurons. In fact, a tight junction connects the cytoplasm of two neurons. And in this case, in principle, communication can happen in both directions.

EXCITATORY AND INHIBITORY SYNAPSES

Synapses act in different ways: therefore, they are called excitatory synapses because they excite the postsynaptic neuron, and they are also called inhibitory synapses because of their inductive effect.

ANOMALIES, PATHOLOGIES OF THE SYNAPSE

The nervous system faces a major challenge: it must adapt to a constantly changing environment, while at the same time maintaining a level of stability that allows it to maintain its integrity and guarantee consistency at the level of behavior. This balance between adaptation and stability changes profoundly over the course of an organism's life. The main abnormalities or pathologies of the nervous system often cause this imbalance:

Parkinson's disease;

epilepsy;

Alzheimer's disease;

psychiatric diseases;

autism.

Even if all the complex molecular mechanisms involved are not understood, for each of its disorders, synapse dysfunction may occur, since synapses are indeed the main element of this central nervous system activity.

PARKINSON'S DISEASE

Parkinson's disease is a neurodegenerative disease of the nerve centers that control automatic movements. This disease is characterized by the progressive degeneration of dopaminergic neurons in the area of the brain that controls motor skills: the lack of dopamine, a neurotransmitter regulator of movements, also leads to cholinergic hyperactivity.

EPILEPSY

Epilepsy is a chronic neurological disorder characterized by sudden, simultaneous and excessive activation of brain neurons. This causes the neurons to discharge irregularly. These convulsive events are the result of an imbalance between excitatory neurotransmitters such as glutamate and inhibitory neurotransmitters such as GABA and aminobutyric acid. The crisis is associated with a decrease in the efficiency of Gabaergic mechanisms.

ALZHEIMER'S DISEASE

This neurodegenerative disease of the central nervous system is characterized by progressive and permanent deterioration of cognitive functions. Clinical presentation refers to dementia syndromes. In terms of pathophysiology, we find intracellular filaments of tau protein. There is hyperphosphorylation of tau with aggregation, impaired axonal flow. This leads to the death of neurons with a decrease in neurotransmitters.

PSYCHIATRIC DISEASES AND AUTISM

A European research project (called CELLSYNCIRCUITS) looked at synapses, and the work suggests that synapse dysfunction may be the root cause of some mental illnesses, such as schizophrenia and autism. . Dr. João Peça of the University of Coimbra in Portugal is conducting research in this area. He reveals: "In this regard, the study of the role of synapses has helped us to understand how information is transmitted in the brain and how synaptic dysfunctions can lead to behavioral disorders such as autism or schizophrenia.. " Thus, the Cordis site of the European Commission confirms: "A closer look at how neural circuits in our brains control certain behaviors and what happens when they malfunction can improve our knowledge of mental illness and lead to better treatments and health policy."

HOW CAN I TREAT SYNAPSE PROBLEMS?

PARKINSON'S DISEASE

Parkinson's disease is treated with special drugs such as L-Dopa, dopamine agonists, dopamine metabolism inhibitors, anticholinergics. Physiotherapy and speech therapy are also available.

EPILEPSY

Treatment of epilepsy consists in eliminating the influencing factors and taking anti-epileptic drugs.

ALZHEIMER'S DISEASE

Therapeutic treatment is related disorders: depression, anxiety, delusions and hallucinations, agitation or aggression. In addition, disease management is essentially psychosocial, with rehabilitation as well as environmental planning.

PSYCHIATRIC DISEASES AND AUTISM

Schizophrenia is also managed by taking antipsychotic drugs, which are sometimes combined with anxiolytics associated with psychotherapeutic work. The possibilities for stabilizing the disease and rehabilitating the patient are increasing, and early detection and early treatment improve long-term functioning.

Austime management is often plural and complex. Thus, the concept of care in the management of autism can be considered from the point of view defined by the clinical psychologist and psychoanalyst Marie-Dominique Amy in one of her works. general and comprehensive consideration of all the needs of the child". For Claude Burzstein, professor of child and adolescent psychiatry, "Giving care to people with autism in terms of need is problematic from the start, because there is no consensus or specific research on the appropriate indications of the various therapeutic methods currently used. not." And this psychiatrist considers the place of this support within the framework of multifaceted care. Indeed, the educational dimension must necessarily be connected and expressed with more clearly therapeutic targeted actions: the physical health of the child the need should not be neglected.

WHAT IS THE DIAGNOSIS?

PARKINSON'S DISEASE

A diagnosis of Parkinson's disease can be made by physical examination and observation of marked improvement after administration of dopamine. In addition, it is necessary to undergo a medical examination to rule out the so-called Parkinson's syndrome, such as a brain tumor or Wilson's disease.

EPILEPSY

The diagnosis of epilepsy is made based on the symptoms associated with the electroencephalogram (EEG).

ALZHEIMER'S DISEASE

An accurate diagnosis can only be made after death. There is still no reliable biomarker or e imaging technique. The current diagnosis is clinical, excluding other causes of dementia, but clinical symptoms are highly variable and often associated with a depressive syndrome present at the onset of the disease, which precludes this question. MMS (Mini Mental Status) counseling is recommended to assess cognitive functions. These are current recommendations that have trial value in France.

PSYCHIATRIC DISEASES: SCHIZOPHRENIA

There is no definitive diagnostic test for schizophrenia. The diagnosis is based on the global evaluation of the medical history and symptomatology. Clinical criteria are described in DSM V (Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition).

AUTISM

Early diagnosis is recommended, but detection is difficult, especially in early childhood, and early warning signs can be detected by parents and child care professionals. If autism is suspected, consultation of specialized groups is indicated.

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