



Role of Neurotransmitters on Memory and Learning

M. Sanmuga Revathi

Research scholar, Center for Research in Education, Thava Thiru Kundrakudi Adigalar College Campus, Kundrakudi, Sivagangai District - 630 206. Tamil Nadu, South India.

Dr M. Parimala Fathima

Research co-ordinator, Center for Research in Education, Thava Thiru Kundrakudi Adigalar College Campus, Kundrakudi, Sivagangai District - 630 206. Tamil Nadu, South India

Dr S.Mohan

Director, Center for Research in Education, Thava Thiru Kundrakudi Adigalar College Campus, Kundrakudi, Sivagangai District - 630 206. Tamil Nadu, South India.

ABSTRACT

The neurotransmitters responsible for the synaptic leap between brain cells are but one category of "informational substances" that carryout the process we call learning. The "informational substances" of the second, parallel system are a variety of transmitters, peptides, hormones and protein ligands. Travelling via intercellular pathways such as the bloodstream, these substances reach receptors on the outer surfaces of cells throughout the body. Some neuroscientists speculate that less than two percent of neuronal communication actually occurs at the synapses between neurons of the brain. The rest of the communication occurs through these informational substances.

KEYWORDS: Neurons , neurotransmitters, memory and learning.

Introduction

In contrast to the nerve impulse, communication between neurons is chemical. The microscopic space between two neurons, over which messages pass, is called a synapse. When an action potential reaches the tips of the axon terminals, neurotransmitters are released into the synaptic gap. Neurotransmitters are chemicals that alter activity in neurons. When chemical molecules cross over a synapse, they attach to special receiving areas on the next neuron. These tiny receptor sites on the cell membrane are sensitive to neurotransmitters. The sites are found in large numbers on nerve cell bodies and dendrites. Muscles and glands have receptor sites, too. Some transmitters excite the next neuron. A single neuron may receive hundreds or thousands of messages. More than 100 transmitter chemicals are found in the brain.

Neurons

Neurons are excitable cells of the nervous system that carry information between the periphery and the central nervous system and , reciprocally, between the various region of the central nervous system. They are thus the basic cells that allow an organism to receive on information about the environment and on this environment , as well as to think, memorize, anticipate, programme an action, and so on.

Neural Regulators

More subtle brain activities are affected by chemicals called neuropeptides. Neuropeptides do not carry messages directly. Instead, they regulate the activity of other neurons. By doing so, they affect memory, pain, emotion, pleasure, moods, hunger, sexual behaviour and other basic processes. The messages for this action are carried by neurotransmitters. Ultimately, brain regulators may help explain depression, schizophrenia, drug addiction and other puzzling topics.

The sequence of chemical events at a synapse

1. The neuron synthesizes chemicals that serve as neurotransmitters. It synthesizes the smaller neurotransmitters in the axon terminals and the larger ones (peptides) in the cell body.
2. The neuron transports the peptide neurotransmitters to the axon terminals. (It doesn't have to transport smaller neurotransmitters because they are formed in the terminals).
3. Action potentials travel down the axon. At the presynaptic terminal, an action potential enables calcium to enter the cell. Calcium releases neurotransmitters from the terminals and into the synaptic cleft, the space between the presynaptic and post synaptic neurons.
4. The released molecules diffuse across the cleft, attach to receptors, and alter the activity of the post synaptic neuron.
5. The neurotransmitter molecules separate from their receptors.

Depending on the neurotransmitter, it may be converted into inactive chemicals.

6. The neurotransmitter molecules may be taken back into the presynaptic neuron for recycling or may diffuse away. In some cases, empty vesicles are returned to the cell body.

Emotion

The gatekeeper of learning.

These molecules are the basic units of a language used by cells throughout the body and brain to communicate across systems such as the endocrine, neurological, gastrointestinal and even the immune system. As they travel, they inform, regulate and synchronize. Peptides are the largest category of informational substances and one kind or another is produced in every cell in the body, not just by cells in the brain. Further more, every peptide known to be produced in the body has receptors in the brain, thus qualifying each peptide to be considered a 'neuropeptide'. This means that the body talks back to the brain, giving it information that alters its messages back to the body. These findings overthrow the distinction traditionally made between body and brain, giving rise to a new concept of "body brain" which reflects the constant collaboration that takes place between mind and body.

A brain triggered by its amygdala has the power to override rational thought and orchestrate a rapid, reflexive response to prepare, for fight or flight to assure survival.

All neuropeptides, causing unique neurophysiological changes as they go about their job of processing and prioritizing information. Thus peptides filter the input of our senses, significantly altering our perception of reality and selecting which stimuli will be allowed in. "Emotions and bodily sensations", says Pert, "are thus intricately intertwined, in a bidirectional network in which each can alter the other".

Endorphins can be found in single-celled animals as well as on up the evolutionary trail, such peptides, in turns out, have been carrying information. "Emotion is the highest part of our mind body survival kit" because one of its key roles is to tell the brain what is worth attending to and the "attitude" with which one attends.

Intelligence: A function of experience

The synaptic leap of an electrical impulse between the axon of one neuron and the dendrite of another is the physical basis of learning and memory. When a pathway of communication within a network of neurons is used repeatedly, it becomes increasingly efficient and we say that we have learned something.

Types and Roles of Neurotransmitters

Serotonin is normally involved in temperature regulation, sensory perception and mood control. However, it plays a major role in emotional disorders such as depression, suicide, impulsive behaviour and aggression.

Acetylcholine is released where nerves meet muscles and is therefore responsible for muscle contraction. After acetylcholine stimulates its receptors, it is quickly inactivated and destroyed by an enzyme. Drugs that keep this enzyme from working are used to treat myasthenia-gravis, a disease of muscle weakness and fatigue.

Norepinephrine, also called noradrenaline is a neurotransmitter that doubles part-time as a hormone. As a neurotransmitter, norepinephrine helps to regulate arousal, dreaming and moods. As a hormone, it acts to increase blood pressure, constrict blood vessels and increase heart rate responses that occur when we feel stress.

Glutamate and GABA (gamma – amino butyric acid) are amino acids that act as neurotransmitters. The majority of synapses within the brain use glutamate or GABA. They also have other functions in the body such as making energy – rich molecules in cells.

The fact that GABA and glutamate are so widely present makes it likely that they will be altered during drug addiction. This also makes it difficult to treat addiction with drug therapy without causing side effects.

Dopamine

One of the neurotransmitters playing a major role in addiction is dopamine. Many of the concepts that apply to dopamine apply to other neurotransmitters as well.

As a chemical messenger, dopamine is similar to adrenaline. Dopamine affects brain processes that control movement, emotional response and ability to experience pleasure and pain.

Regulation of dopamine plays a crucial role in our mental and physical health neurons containing the neurotransmitter dopamine are clustered in the midbrain in an area called the substantia nigra. In Parkinson's disease, the dopamine – transmitting neurons in this area die. As a result, the brains of people with Parkinson's disease contain almost no dopamine. To help relieve their symptoms, we give these people L-Dopa, a drug that can be converted in the brain to dopamine.

Dopamine antagonists are traditionally used to treat schizophrenia and related mental disorders. A person with schizophrenia may have an overactive dopamine system. Dopamine antagonists can help regulate this system by "turning down" dopamine activity.

Some postsynaptic neurons respond to stimulation by releasing special chemicals that travel back to the presynaptic terminal, where they inhibit further release of transmitter. Nitric oxide is apparently one such transmitter. Two others are anandamide and 2-AG (Sn-2-arachidonylglycerol) both of which bind to the same receptors as marijuana extracts.

Many neurons release nitric oxide when they are stimulated. In addition to influencing other neurons, the nitric oxide dilates the nearby blood vessels, thereby increasing blood flow to that area of the brain.

Conclusion

The dialogue among educators, neuroscientists and others who are seeking to understand the biology of human learning is really just beginning. But already there is much to inform our practice. We can begin by acting on three of the key findings so far: the role of emotions in focusing attention, the importance of providing many first – hand experiences and building in personal meaning from the student's point of view. Through their use of hands – on, field study approaches, many environmental educators are already stepping ahead in acting on the research about the magical ways in which the body and brain work together to learn.

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