Analysis of the Function and Role of Brain Neurotransmitters in Individual Activities

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1. Introduction

A remarkable network of nerves orchestrates the intricate functions of the human brain, serving as the central command center for both bodily and mental processes. Neurotransmitters are vital molecules in the neurological system that govern communication between neurons by delivering signals. Studying the function and role of brain neurotransmitters is crucial for comprehending the mechanisms behind various physical and mental functions. Neurotransmitters are chemical substances synthesized by neurons that carry information or impulses between nerve cells. Every neurotransmitter has a distinct purpose and function in controlling several parts of daily living, including mood, motivation, focus, and even response to stress. Hence, possessing a profound comprehension of the mechanisms by which neurotransmitters function can offer significant insight into an individual's mental and physical well-being.

An in-depth examination of the function of brain neurotransmitters is crucial in the realm of health and psychology, particularly due to the frequent correlation between neurotransmitter imbalances and a range of psychological diseases, including depression, anxiety, and mood disorders. By examining the intricate connections between neurotransmitters and individual behavior, we not only gain an understanding of the biological

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underpinnings of human actions but also establish a basis for the creation of more efficient therapeutic methods.4-6 This review aims to describe the function and role of brain neurotransmitters in person activities.

**Gamma-Aminobutyric Acid (GABA)**

GABA, being the primary inhibitory neurotransmitter, exerts a tranquilizing effect by diminishing neuronal activity in the brain. GABA functions by suppressing excitatory signals, which promote heightened neural activity. GABA aids in preserving an equilibrium between stimulating and restraining messages, which is crucial for optimal brain functionality. GABA's capacity to decrease neuronal activity commonly links it to the reduction of anxiety and tension. Anomalies in the GABA system have been associated with anxiety disorders and maybe even epilepsy. Certain sedatives or hypnotic medications function by enhancing the potency of gamma-aminobutyric acid (GABA) in the brain. This can alleviate symptoms such as sleeplessness and uneasiness. The primary mechanism of action for most anti-epileptic medicines is the enhancement of GABA activity, thereby facilitating the suppression of neural impulses that may trigger seizures. The body derives the majority of GABA from organs other than the brain, such as the kidneys and lungs, even though GABA serves as the primary neurotransmitter in the brain. GABA also plays a role in the control of physiological processes such as blood pressure and the immune system.7,8

**Glutamate**

Glutamate, functioning as an excitatory neurotransmitter, enhances neuronal activity by activating cation channels in nerve cell membranes. This leads to the depolarization of nerve cells, resulting in accelerated and more effective signal transmission. Glutamate plays a vital part in brain plasticity, which refers to the brain's capacity to adjust and modify itself. Synaptic plasticity plays a crucial role in learning and memory processes by facilitating the creation and modification of synaptic connections among neurons. Glutamate attaches to particular receptors, namely NMDA and AMPA receptors. The activation of NMDA receptors plays a role in the formation of long-term memories and learning, whereas AMPA receptors are responsible for facilitating quick responses to glutamate. While glutamate plays a crucial role in maintaining proper brain function, an excessive amount of glutamate can lead to harm and damage to nerve cells. Excitotoxicity refers to a condition where excessive levels of glutamate lead to harmful effects on nerve cells, contributing to the development of several neurodegenerative disorders.9,10

Medications that modulate the glutamate system, such as anti-epileptic pharmaceuticals and neuroprotective compounds designed to safeguard nerve cells from harm, can manage neurological illnesses like Alzheimer's disease, Parkinson's disease, and schizophrenia. Alterations in the glutamate system have been associated with a range of neurological disorders, such as Alzheimer's disease, Parkinson's disease, and schizophrenia. Hence, investigating the control of glutamate could offer a valuable understanding of the underlying molecular mechanisms of these disorders. Gaining a more profound comprehension of the function of glutamate is not only significant in the field of neuroscience but also holds possible ramifications for the advancement of treatments that could manipulate the glutamate system to enhance brain function or even address specific neurological disorders.11,12

**Dopamine**

Stimuli that elicit pleasure or reward frequently link to dopamine reactions. When individuals encounter pleasurable or gratifying stimuli, such as delectable cuisine, successful attainment of objectives, or other favorable events, they experience elevated dopamine levels. Dopamine plays a crucial role in motivation and the regulation of behavior. When the dopamine system is operating optimally, it can offer essential motivational enhancement to pursue objectives and fulfill fundamental requirements. Several neuropsychiatric illnesses have been associated with imbalances in the dopamine system. Heightened dopamine activity may influence bipolar...
disorder, while reduced dopamine activity has been linked to schizophrenia. Drug development for these illnesses frequently focuses on modulating the dopamine system.\textsuperscript{13,14}

Dopamine also has a role in cognitive processes related to learning and memory. Elevating dopamine levels can enhance the brain's capacity to process and retain novel information. Dopamine not only affects cognitive and emotional function but also regulates physical movement. Neurological illnesses such as Parkinson's disease are associated with a lack of dopamine, resulting in symptoms like tremors, muscle rigidity, and impaired mobility. Malfunctions in the dopamine pathway can also contribute to mood disorders and anxiety issues. Therefore, pharmaceuticals that influence dopamine can be used to manage mood and anxiety disorders. Gaining a deeper comprehension of the function of dopamine has been a primary area of emphasis in neuroscience investigations, and subsequent findings could potentially pave the way for the creation of more efficient therapeutic approaches for a range of neuropsychiatric conditions.\textsuperscript{15}

**Serotonin**

Serotonin is commonly known as the “happiness” neurotransmitter due to its involvement in the control of mood. Depressive illnesses have been associated with a shortage of serotonin, a neurotransmitter. This imbalance can manifest as feelings of melancholy, a lack of interest or joy, and decreased energy levels. Serotonin is also involved in the control of sleep patterns. Elevated serotonin levels in the brain have been associated with improved sleep, whereas a shortage of serotonin may contribute to sleep disorders such as insomnia. Serotonin also plays a role in the regulation of hunger. Increased levels of serotonin can result in sensations of satiety and contentment following a meal, whereas a shortage of serotonin may be linked to heightened cravings, particularly for carbs.

In addition to depression, serotonin depletion is also associated with anxiety disorders. Serotonin exerts a tranquilizing influence and can aid in alleviating symptoms of anxiety. Serotonin also has an influence on cognitive function, encompassing attention, learning, and memory. Dysfunctions in serotonin can have an impact on cognitive abilities and the ability to focus. Serotonin also plays a role in regulating the respiratory system. Imbalances in serotonin levels can lead to the development of respiratory problems, such as sleep apnea. Enhancing comprehension of the function of serotonin has been a primary area of interest in the advancement of psychiatric medications, particularly antidepressants that function by augmenting serotonin levels in the brain. By gaining a deeper comprehension of the intricacies of neurotransmitter interactions, there is an optimistic outlook for the development of therapeutic strategies that are both more efficacious and customized to meet individual requirements.\textsuperscript{16,17}

**Norepinephrine (noradrenaline)**

Norepinephrine, along with epinephrine (adrenaline), participates in the body’s response to stressful or perilous circumstances by facilitating the release of energy. This process entails the liberation of glucose from the liver into the bloodstream, augmenting the circulation of blood to the muscles, and provoking the generation of energy. Norepinephrine is crucial in the augmentation of heart rate (tachycardia) and the elevation of blood pressure. This facilitates enhanced blood circulation to essential organs and augments the accessibility of oxygen and nutrients during periods of stress. Norepinephrine is a primary neurotransmitter in the sympathetic nervous system, which is accountable for reacting to stressful circumstances. The sympathetic nervous system collaborates with the parasympathetic nervous system to sustain homeostasis in the body. Besides its involvement in the “fight or flight” response, norepinephrine also plays a function in regulating mood. An imbalance of norepinephrine can contribute to mood disorders such as depression and anxiety. Norepinephrine additionally contributes to the enhancement of alertness and concentration levels. Norepinephrine exerts influence on cognitive function, specifically on the processes of learning and memory. Elevating norepinephrine levels can enhance the brain’s capacity to process and retain novel
information. Certain drugs, such as sedatives or stimulants, have the ability to influence the levels of norepinephrine in the brain. The utilization of these medications can impact one's mood, attentiveness, and reaction to stress.  

\textbf{Acetylcholine}

Acetylcholine is crucial for transmitting signals between neurons and muscles at a neuromuscular synapse. When a nerve impulse reaches the nerve terminal, it discharges the neurotransmitter acetylcholine into the synaptic cleft, where it attaches to the acetylcholine receptors in the muscle, initiating muscular contraction. Acetylcholine also plays a role in cognitive function, specifically in memory and learning processes. The brain's hippocampus and other regions have a significant number of receptors for acetylcholine. Alterations in the acetylcholinergic system can impact the brain's capacity to create and retain memories. Acetylcholine also has a role in regulating levels of consciousness and vigilance. The acetylcholinergic system interacts with the central nervous system to control the patterns of sleep and wakefulness and influence the level of awareness during periods of wakefulness. Besides its involvement in neuromuscular transmission, acetylcholine also contributes to the regulation of involuntary movements, such as those controlled by the autonomic nervous system. Neurological illnesses, such as Alzheimer's disease, are associated with disorders of the acetylcholinergic system. Alzheimer's patients experience poor memory and cognitive function due to reduced amounts of acetylcholine in the brain. Doctors employ acetylcholinesterase enzyme inhibitors, like various medicines, to treat specific neurological disorders, such as Alzheimer's disease. Their purpose is to elevate acetylcholine levels and enhance cognitive function.  

\textbf{Histamine}

Neurons in the brain, particularly in specific regions like the hypothalamus, generate and discharge histamine. This causes it to function as a neurotransmitter within the central nervous system. Histamine exerts a stimulatory influence on the brain. Elevated histamine levels Nivea has the potential to enhance wakefulness and inhibit sleep. Hence, antihistamine medications commonly employed for allergy treatment can induce sleepiness due to their ability to permeate the blood-brain barrier and impact the control of sleep cycles. Aside from its role in regulating sleep, histamine may also contribute to cognitive processes such as attention, learning, and memory. The histaminergic system encompasses the synthesis, secretion, and functioning of histamine. Histamine receptors, specifically the primary types (H1, H2, and H3), are present throughout the central nervous system and regulate the impact of histamine on different brain activities. Histamine can also impact the control of body temperature. Elevated levels of histamine can induce vasodilation, leading to the expansion of blood vessels and impacting the control of body temperature.

2. Conclusion

Neurotransmitters are chemical substances that facilitate the transmission of signals between neurons in the brain. Their function is crucial in governing diverse areas of the human brain and bodily functions. Intricate connections among neurotransmitters, brain circuitry, and environmental influences influence individual activity.

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