

Developing Brains- Ideas for Parenting and Education From the New Brain Science

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Glossary of Terms

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Introduction to the Glossary:

The definitions that follow were constructed by pulling together definitions from numerous authors (see list at the end). A glossary can be used in several ways. You can use it as a specialized dictionary for looking up specific terms you encounter. You can also use it as a way to learn more about a subject, in this case the brain. One way to do that is to start by reading an entry and then looking up other terms that are in the definition, sort of "wandering" through the glossary.

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Action Potential - is the nerve impulse that travels along neurons and across synapses. It represents information in the nervous system. The action potential is an all-or-nothing electrical signal that is triggered by stimulation of a receptor site on the neuron. It travels through the cell body and down the axon as an electric impulse. When it reaches the axon's terminal buttons, the signal becomes chemical through the release of neurotransmitters into the synaptic cleft. The term "potential" is another word for voltage.

Amygdala - a part of the forebrain that is concerned with integrating and coordinating emotional behaviors, especially fear, anxiety, and aggression. It is located in the temporal lobes of the cerebral hemispheres.

Association Cortex or Areas- the areas of the cerebral cortex that contain higher functions such as language and personality, but are not involved directly in motor and sensory functions. These areas integrate information from all other brain areas.

The prefrontal cortex is "one of the two great areas of multimodal association cortex in human brains, important for working memory, planning, and choosing appropriate responses to social and life situations." (Nolte)
The second great area of association cortex is the parietal-occipital-temporal association cortex.

Attention - selective focusing on something in the environment, which is a basis of being conscious.

Autonomic Nervous System (ANS) - (a division of the Peripheral Nervous System) is comprised of nerves that are connected to and regulate the heart, glands, blood vessels, and smooth muscles. Much of this regulating is involuntary (autonomically). The ANS has two subdivisions: the sympathetic division and the parasympathetic division. The **Parasympathetic division** generally conserves the body's resources, allowing digestion and lowering the heart rate, and is sometimes referred to as "rest and digest". The **Sympathetic division** mobilizes the body to respond to danger and emergencies, referred to as the "fight-flight" or stress response.

Axon - is a long appendage or outgrowth (called a "process") attached to the neuron's cell body, which transmits the signal away from the cell body to other neurons, as well as to glands and muscles. The axon is the "sending" fiber of the neuron. Nerves are bundles of axons.

Basal ganglia - are a set of structures in the forebrain that are involved in motor control (both the initiation and execution of movements).

Brain - is the whole Central Nervous System except for the spinal cord. It includes the two cerebral hemispheres, the diencephalons, the cerebellum, and the brain stem.

Brain Stem - is a term that describes a part of the brain that is connected to the spinal cord at one end and to the brain at the other. It contains three structures: the medulla, pons, and midbrain. The **medulla** regulates such unconscious or autonomic functions as digestion, breathing, circulation, and heart rate. The **pons** sends information about body movement from the cerebral hemisphere to the cerebellum and is involved in sleep and arousal. The **midbrain** controls a number of motor and sensory functions, such as eye

movements, and integrates senses such as hearing and vision. The brain stem also contains the **reticular formation** which regulates states of arousal and levels of consciousness. This and other autonomic structures that make up the brain stem are essential for survival.

Cell body - is the part of the neuron that does the "work" of the cell. It contains the nucleus of the cell and controls, in most neurons, the electric signals that are moving through the neuron.

Cell Membrane - "the outer layer of a cell that controls the passage of chemicals between the external environment and the cell's interior."
(NSCDDC)

Central Nervous System (CNS) - is composed of the brain and spinal cord. The CNS is one of two components of the Nervous System. The other is the Peripheral Nervous System.

Cerebellum - is an area of the brain that is involved in the planning, learning and coordination of motor skills and balance. It also coordinates fine muscle movement. The cerebellum receives information from the sensory systems, the cerebral cortex and other sites.

Cerebral Cortex - is the outer layer of grey matter in the cerebrum that has deep folds and looks like a cauliflower. The cortex is divided into two hemispheres, a right hemisphere and a left hemisphere. Motor wise, the right hemisphere controls the left side of the body and the left hemisphere controls the right side of the body. The cerebral cortex includes the olfactory areas (smell) and the hippocampus as well as the neocortex.

Cerebral Hemispheres - are the right and left halves of the cerebrum which are connected by the corpus collosum. The cerebral hemispheres can be "divided" into four lobes: frontal, temporal, parietal, and occipital.

Cerebrum - is a "collective term" for the basal ganglia, cerebral cortex and limbic system. It is the outer part of the brain that is very large in humans and is responsible for complex thought, including such abilities as: thinking, learning, emotion, consciousness, integration of input from the senses, and

motor movement that is voluntary. The cerebrum is divided into two hemispheres, with most structures being in pairs, one in each hemisphere.

Corpus Callosum - is a large bundle of nerve fibers (axons) which connects the two hemispheres of the cerebrum, and allows the hemispheres to "talk" to each other.

Cortisol - is a "steroid hormone released from the adrenal glands during stress" (Dowling)

Critical Period - is a time period during child development that is limited and is the optimal time for brain circuits, which are genetically determined, to be influenced by experiences and the environment. The development of vision in the first 7 months of life (postnatal) is an example of a critical period. If a child, for example, is born with a cataract on an eye, and it is not removed right away, during the critical period, the brain will never achieve its ability to "see" out of that eye. The human brain must get clear visual signals from the eye during the first 7 months of life to be able to see.

Dendrites - are the places on most neurons that receive a signal from the axon of the sending neuron. Dendrites are the individual branches of the "feeler like structures called dendritic trees." (Weiten)

Diencephalon - is referred to as the "in-between-brain" because it is located between the midbrain and the cerebral hemispheres. It contains the thalamus and hypothalamus, and, by weight, it is only 2% of the weight of the brain.

Forebrain - is the largest and most complex part of the brain. It is made up of the cerebrum (called "telencephalon") and the diencephalon.

Frontal Lobe - is the most forward part of each cerebral hemisphere and contains the motor cortexes. It also contains the orbitofrontal cortex and the prefrontal cortex which are connected to all other lobes of the cerebral cortex as well as to the limbic system, by long association fibers. According to Nolte, the frontal lobe is important to "working memory, regulating emotional tone, prioritizing bodily/environmental demands, and stabilizing

short- and long-range goal-directed activity," (613) among other "executive" functions.

Glial Cells - are one of the two major types of cells in the nervous system. (The other cells are neurons.) There are 10-50 times more **glia** (the plural for glial cell) than neurons, and glia are smaller than neurons. Glia provide support for the neurons, doing things such as nourishing the neurons; protecting neurons by providing and maintaining the myelin sheath for the axons; and, recycling neurotransmitter and cleaning up the "cellular debris" (such as unused neurotransmitters in the synaptic cleft and debris that is left after an injury to the brain or the death of neurons). Glia are also involved in the development of the brain, providing "fibers" or "scaffolding" on which migrating neurons travel. There is new evidence that glia can communicate with each other and are involved in learning and memory.

Gray Matter - refers to areas of the brain and spinal cord that have a lot of neuron cell bodies and dendrites. This area is actually a "pinkish" gray, due to all the blood vessels.

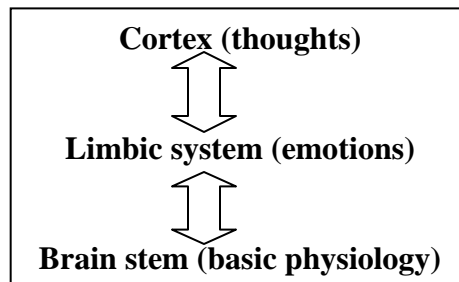
Hindbrain - is the part of the brain that contains the cerebellum, the medulla, and the pons. The medulla and pons are basically extensions of the spinal cord that are in the skull, and they contain sensory and motor pathways that move information in both directions. These pathways bring information from the peripheral nervous system to the brain, and send signals from the brain to the rest of the body, including organs and muscles.

Hippocampus - is a part of the brain that is found under the temporal lobes and is critically involved in both learning and memory storage. The hippocampus is one of the areas of the brain that continues to create new neurons throughout the lifespan.

Hypothalamus - is a part of the diencephalon. It regulates such basic biological needs as hunger, thirst, sex drive, body temperature, and the "fight-flight" response to extreme stress. It regulates the autonomic nervous system, the release of hormones from the pituitary gland, and plays a role in emotional behavior.

Limbic System - is not an actual structure or area of the brain but is a collection of parts of the brain, including parts of the hypothalamus, thalamus as well as the hippocampus and the amygdala. It is located along the edge or "border of the cerebral cortex and deeper subcortical areas." (Weiten, 92) The limbic system is involved in memory, learning, and emotion, as well as the so-called "pleasure centers" of the brain.

The limbic system is directly connected to both the cortex and the brain stem.



Medulla - see Brain Stem

Midbrain - is a part of the brain stem that is between the forebrain and the hindbrain, and is the smallest of the 3 divisions of the brain. It contains extensions of the reticular formation. It also has two sets of structures that process visual and auditory information. The visual structures help "in the coordination of head and eye movements in relation to visual attention." (Green, 38)

Mirror Neurons - are a subset of cells in the brain that are organized into vast and complex networks. They hold templates or patterns for specific actions, and they allow us to imitate the actions of others. Mirror neurons also allow us to read and copy the emotions and intentions of other people. They help us understand the social meaning of other's behavior.

Myelin Sheath - is an insulating sheath made of a type of fat (proteolipid) that covers or encases most axons. This "insulation" promotes rapid and error-free conductivity of the signal traveling down the axon. If something happens to the myelin sheath and causes it to deteriorate, the axon's ability to transmit the signal is disrupted. Myelination of axons occurs throughout development and into early adulthood. Glial cells myelinate the axons.

Nerve Impulse - is another term for "action potential".

Nerves - are bundles of axons (neuron fibers) that are "routed together in the peripheral nervous system." (Weiten) They are protected by the myelin sheath.

Neocortex - is the "six-layered covering to the forebrain" and is the part that is "responsible for higher cognitive functions." (Green) It is organized into primary sensory and motor areas (where signals first arrive), association areas, and limbic areas.

Neural Cell Migration - is "an important part of the early embryonic development of the brain characterized by the movement of nerve cells from the place where they originate to specific locations where they form specific brain structures." (NSCDC)

Neural Circuit - "is a network of connections among neurons that performs a specific function (e.g., visual circuit) (NSCDC)

Neurons - are the fundamental information processing units and one of the two types of cells in the nervous system. (The other cells are glial cells.) Neurons (which are individual cells) receive, integrate, and transmit information from one neuron to another in the form of nerve impulses. They create networks of connections within the brain, and between the brain and the rest of the body. Some neurons transmit information from the nervous system to the muscles that move our bodies. Neurons come in a great variety of types, shapes, and sizes; however they have some common features.

Neurotoxicity - is the state or quality of something having a poisonous (toxic) impact on neurons or on neural networks.

Neurotransmitters - are "chemicals that transmit information from one neuron to another" (Weiten) either by exciting or inhibiting the receiving neuron. Neurotransmitters are naturally occurring and are made in the cell body. They travel down the axon and are stored in synaptic vesicles in the terminal button until they are released, which is where they send information (the action potential) from one neuron to another. "A specific

neurotransmitter can bind only to receptor sites that its molecular structure will fit into, much like a key must fit a lock." (Weiten) (See the chart of neurotransmitters at the end of the glossary.)

Occipital Lobe - is the most rear part of each hemisphere of the cerebral cortex. It includes the primary visual cortex and is the area that receives and processes visual sensory input.

Orbitofrontal Cortex - is an area in the lower part of the frontal lobes that is involved in the expression of emotional behaviors.

Parietal Lobe - is located on the "top" of the hemispheres of the cerebral cortex, and contains the primary somatosensory cortex, and is involved in language, perception, and more complex spatial orientation.

Peripheral Nervous System (PNS) - is one of the two components of the nervous system, which though separate, are fully interconnected. The Central Nervous System is the other system. The Peripheral Nervous System is comprised of all the nerves that lie outside of the brain and spinal cord. It is further divided into the Autonomic Nervous System and Somatic Nervous System.

Pituitary Gland - (located in the base of the brain) is called the "master" gland as it regulates and stimulates other endocrine glands, which release hormones that spread out in the body.

Pons - see Brain Stem

Prefrontal Cortex - is the part of the Frontal Lobe that is just behind the forehead. It is responsible for higher-order functions such as decision making, impulse control, working memory, time sequences, and reasoning. It is the part of the brain that is involved in planning, paying attention, and organizing. The prefrontal cortex is the last to finish developing in the late teens and early twenties.

Receptor Sites - (or synaptic receptors) are specialized molecules (protein macromolecules) in the membrane of the receiving neuron (**postsynaptic**). These sites are where neurotransmitters from the sending neuron

(**presynaptic**) can bind with the receiving neuron, completing the communication between the cells, and starting the process leading to an action potential (nerve impulse) in the postsynaptic neuron.

Reticular Formation - is composed of neurons found in the medulla which extend throughout the brain. See Brain Stem.

Sensitive Period - is a period of time during a child's development that is the "best" time for certain abilities to emerge. During a sensitive period, the child is especially sensitive to the influence of experiences and the environment. The outer boundaries or limits of the period are not as sharp as in a critical period. Experiences that come after the sensitive period can still influence the child, but it is harder than during the sensitive period. The first 12 years of life are a sensitive period for learning a second language.

Soma - is the cell body of the neuron. The soma contains the nucleus of the cell as well as the chemical machinery that is common to most cells.

Somatic Nervous System (SNS) - (Somatic division of the Peripheral Nervous System) gives sensory information about limbs and muscles and their relative positions, from nerves that are connected to the voluntary muscles of the skeleton and sensory receptors in the skin. It also tells us about the environment outside the body.

Synapse - is the "specialized site of communication" (Kendall, et. al.) between two neurons where information is passed (transmitted) from one neuron to another neuron, in order to excite or inhibit the next neuron in line. Typically, the synapse is the space (called the **synaptic cleft**) between the end point of the axon (called the **terminal button**) of the sending neuron and a dendrite of the receiving neuron. "Nerve impulses are carried across [the synapse] by the action of neurotransmitter chemicals." (Green) Synapses are also the site of "functional contact" between a neuron and a muscle.

Communication at the synapse is either chemical or electrical. A **Chemical Synapse** - according to Kendall, et. al., is a synapse where the sending neuron (presynaptic) "releases a neurotransmitter that binds to receptors" on the receiving (postsynaptic) neuron. The two cells (neurons) are separated by a

microscopic space, the synaptic cleft. **Electrical synapse** - according to Kendall et. al., is "a synapse at which *current* flows directly" from the sending neuron (presynaptic neuron) to the receiving neuron (postsynaptic neuron). The two cells (neurons) are actually connected by structures called "gap-junctions." Neurons that are connected by electrical synapses are able to fire all together to "produce *explosive* behaviors, e.g., escape."

Temperament - refers to individual differences that are seen early in childhood and remain relatively stable over time, becoming a base for the developing personality. Temperament includes differences in reactivity and in self-regulation. According to Berk, "reactivity refers to quickness and intensity of emotional arousal, attention, and motor activity. Self-regulation refers to strategies that modify reactivity."

Temporal Lobe - is located on the "sides" and undersides of the two hemispheres of the cerebral cortex. It includes the auditory cortex, which processes sound, and the association areas. It also includes parts of the visual cortex, language areas, olfactory cortex (smell), the amygdala, and hippocampus (concerned with memory).

Terminal Button - (or "synaptic bouton") is an enlarged place or knob at the end of the axon where neurotransmitters are released or secreted.

Thalamus - is a part of the diencephalon and it processes information coming to the cerebral cortex from all the other parts of the central nervous system. It is involved in processing of sensory information, memory, and arousal.

Vesicles - are "spherical storage containers within the presynaptic terminal, filled with neurotransmitter chemicals. These are released into the synapse when the vesicles merge with the presynaptic membrane." (Green)

White Matter - refers to parts of the brain and spinal cord that have a lot of myelinated axons, which give this tissue its white color.

Characteristics and functions of common neurotransmitters

Neurotransmitter	Characteristics and Functions
Acetylcholine (ACh)	<p>This controls skeletal muscles and is released at neuromuscular junctions and at some synapses in the brain and spinal cord.</p> <p>Helps regulate attention, arousal, and memory.</p> <p>Some of these ACh receptors can be stimulated ("fooled") by nicotine. This can be very disruptive to fetal brain development.</p>
Dopamine (DA)	<p>Helps control voluntary movements.</p> <p>DA also helps control pleasurable emotions.</p> <p>Low levels of DA are associated with Parkinson' disease. Too much activity at dopamine synapses is found in schizophrenics and in people who use cocaine, heroin, nicotine, alcohol, and amphetamines ("speed").</p>
Endorphins	<p>The "feel good" neurotransmitters which are similar to opiate drugs (such as morphine) in both their structure and effects. They both dampen pain and increase pleasurable feelings and emotions.</p>
GABA (gamma-aminobutyric acid)	<p>It works by inhibiting the sending of signals between neurons. GABA plays a key role in regulation of sleep. It may also regulate anxiety by inhibiting neurons that cause anxiety. Too little GABA increases anxiety.</p>
Glutamate	<p>Glutamate (an excitatory neurotransmitter) is the most common neurotransmitter in the central nervous system. It is involved in memory. Too much glutamate will kill neurons. This can happen as the result of brain damage or stroke and cells can be killed long after the damage was done.</p>
Norepinephrine (NE) -also called noradrenaline	<p>Works to help modulate a person's mood and arousal.</p> <p>Increases blood pressure and heart rate in the face of "danger" and prepares the brain to respond to anger. It also helps with memory. Cocaine and amphetamines increase activity at these synapses.</p> <p>Too much NE can lead to impulsive behavior, whereas too little NE can lead to thrill seeking behavior.</p>

Serotonin	<p>Serotonin is the "brain's master impulse modulator for all our emotions and drives. (EHSNRC) It helps regulate eating, sleeping and wakefulness.</p> <p>Low levels of serotonin are involved in depression, suicide, anger control, impulsive aggression and alcoholism. It is at serotonin synapses that antidepressant medications work. Low serotonin levels can also lead to an increased appetite for foods high in carbohydrates, as well as cause sleep problems. High levels of serotonin can increase such things as shyness, fearfulness, and lack of self-confidence. High levels also are involved in obsessive-compulsive disorder and "unduly dampened" aggression. In addition, atypical levels of serotonin have been found to be related to migraine headaches, fibromyalgia, and irritable bowel syndrome.</p>
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Definitions of terms are based on those found in:

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