

Glossary

acetylcholine (**Ach**; uh-see-tel-KO-leen): A neurotransmitter in the central and peripheral nervous system. See Chapter 16.

acetylcholinesterase (**Ache**; uh-see-tel-KO-leen-ES-ter-ayze): An enzyme that deactivates acetylcholine, to clean up the synapse.

acoustical analysis (uh-KOO-sti-kul uh-NAL-ih-sus; Greek *akoustikos* = of hearing): The process of interpreting physical sound energy, whether linguistic, musical, or sounds in the environment (as in a door slamming or a car starting). See Chapter 11, 'Introduction'.

action potential (AK-shun po-TEN-shul): In neurons, an electrochemical signal beginning near the cell body and traveling down the axon to the synaptic terminal. Also called a 'spike' or 'neuronal firing'. See Chapter 3, 'Introduction'.

adenosine (uh-DEN-oh-seen): An inhibitory neurotransmitter that is believed to promote sleep and suppress waking arousal. See Chapter 16.

adrenaline (uh-DREN-uh-lin; from Latin, *ad-* = on top of; *renes* = kidney; *-in* = protein): Also called epinephrine, it is a peripheral hormone and brain neurotransmitter. As a circulatory hormone it is released by the adrenal gland, located on top of the kidneys, and prepares the body for fight or flight. See Chapter 16.

affective blindsight (uh-FEK-tiv BLIND-site; Latin *affectus* = emotion): An inability to understand emotional facial expressions. See Chapter 13, 'The Fear System'.

agonist (AGG-uh-ist; Latin for competitor). A molecule that binds to a neural receptor, thereby increasing the chance that the postsynaptic neuron will fire. See Chapter 16, 'Remembering the Words'.

alpha waves (AL-fa WAY-vz; first letter of Greek alphabet): A regular electromagnetic wave detected in the brain or on the scalp, and apparently reflecting the activity of large populations of neurons. Alpha waves have a frequency of 7.5 to 13 Hz and originate predominantly from the occipital lobe

during periods of waking relaxation with the eyes closed. Conversely, alpha waves are decreased when the eyes are open, as well as by drowsiness and sleep. See Chapter 4, 'A Range of Useful Tools'.

amino acid (uh-MEE-no AE-sid): A constituent part of a protein molecule. Amino acids are critical to life, and have a large variety of metabolic roles. All amino acids contain both an NH₃ (amine) and a COOH (carboxyl) group. See Chapter 16.

amnesia (am-NEE-zhuh; from Greek *a-mn-sia* = not memory): A loss of memory. Two types are anterograde (a loss of memory after the time of the brain injury) and retrograde (a loss of memory before the time of the brain injury). See Chapter 9, 'Amnesia'.

amygdala (uh-MIG-da-la; from *amygdale* = almond): The amygdalas are two small, almond-shaped masses of neurons located inside the tips of the temporal lobes. They are considered part of the limbic system and play major roles in emotions like fear and trust, as well as in learning. See Chapter 1, 'Some History, and Ongoing Debates'.

antagonist (ann-TAG-uh-nist; Latin for competitor): A molecule that binds to a receptor and blocks or inhibits its activity. See **agonist**.

anterior (ann-TEER-ee-er; from *ante* = in front of): Located in front of something. See Chapter 1 and the Mini-Atlas on the inside front cover.

anterior cingulate cortex (an-TEER-ee-er SIN-gyu-lut COR-teks; from Latin *ante* = before, in front of; Latin *cingulum* = girdle; Latin *cortex* = bark): The frontal part of the cingulate cortex. The anterior cingulate cortex is involved in executive functioning. See Chapter 2, 'The Central Executive'.

anterior commissure (an-TEER-ee-er KA-mih-shur; from Latin *ante* = before, in front of): A large bundle of nerve fibers connecting the two cerebral hemispheres. See Chapter 5, 'Introduction'.

anterograde amnesia (AN-teh-ro-grayd am-NEE-zhuh; from New Latin *antero-* = forward; Greek *a-mnēsia* = not memory): A form of amnesia in which events after the brain injury are not encoded in long-term memory, although events may be recalled from the period before the injury. See Chapter 9, 'Amnesia'. See **retrograde amnesia**.

aphasia (AY-PHAY-zha; from, *a* = without; Latin *phasia* = speech): A loss of language function due to brain injury, such as damage to Broca's area, for speech production, or Wernicke's area, for speech understanding. See Chapter 1, 'Some History, and Ongoing Debates', and Chapter 7, 'Speech Perception'.

apparent motion (uh-PAR-ent MO-shun; from Latin *apparere* = to appear; Latin *movere* = to move): A form of perceptual filling-in in which the brain creates the illusion of motion when a series of still images are flashed one after the other. See Chapter 6, 'Linking Brain Activity and Visual Experience'.

arcuate fasciculus (AR-cue-ate fa-SIK-u-lus; Latin for curved bundle): A bundle of axonal fibers, especially the ones connecting Broca's and Wernicke's areas in the left hemisphere. See Chapter 1, 'Some History, and Ongoing Debates'.

area MT: A part of visual cortex that represents visual motion. See Chapter 6, 'Functional Organization of the Visual System'.

array (uh-RAY): 1. A two-dimensional grid of sensory receptors, such as the retina. 2. A two-dimensional grid of higher-level elements in the visual hierarchy. Many 'layered' brain structures can be considered to be such arrays. See Chapter 3, 'Arrays and Maps'.

artificial neural net (ar-ti-FI-shel NOOR-el NET; from Greek *neuron* = nerve): Also known as ANNs or neural models, artificial neural nets are simulated, simplified models of brain functions. Most are relatively small in scale. However, they are important for understanding the principles of neural computation. See Chapter 3, 'Introduction'.

associative process (uh-SO-see-a-tiv PRA-ses; from Latin *ad-* + *sociare* = to join): A process in which one or more sensory and/or response events are linked in the brain. See Chapter 5, 'From 'Where' to 'What': The Functional Roles of Brain Regions'.

attention (a-TEN-shun; from Latin *attendere* = to stretch out): Selection of some sensory, cognitive, or motor events to the exclusion of others. Attention is often taken to involve a focus on certain conscious events. Also see selective attention. See Chapter 8.

attention deficit (hyperactivity) disorder (ADD or ADHD); uh-TEN-shun DEF-ih-sit hy-per-ak-TIV-ih-tee dis-or-der): A persistent pattern of impulsiveness and difficulty with sustained attention, with or without a component of hyperactivity. There is some debate whether it is a genuine disorder or a normal adaptation that may be problematic today. It affects 3 to 5% of children around the world and continues

into adulthood for 30–50% of those affected. See Chapter 12, 'ADHD'.

attention network task (ANT); a-TEN-shun NET-werk TASK): A generalization of the **flanker task**, a tool for studying visual attention. The ANT allows testing of three separate aspects of attention: alerting before an expected signal, orienting to a specific location in space where the target is expected, and executive attention to act against expectations set up by the task. See Chapter 8.

auditory cortex (AW-di-tor-ee kor-teks; from Latin *auditorius* = pertaining to one who hears; Latin *cortex* = bark): The parts of the cerebral cortex involved in processing sounds, such as Wernicke's area and Heschl's gyrus. See Chapter 7, 'The Central Auditory System'.

auditory scene analysis (AW-di-tor-ee SEEN uh-NAL-ih-sus): The process by which the auditory system segments and organizes the listening environment. See Chapter 7, 'Introduction'.

autism spectrum disorders (ASD); AW-tizm SPEK-trum dis-OR-der): A range of conditions characterized by deficits in social perception and communication, repetitive behavior, and other symptoms.

autonomic nervous system (ANS); aw-to-NOM-ic NER-vus SIS-tem; from Greek *neuron* = nerve): The division of the peripheral nervous system that acts to maintain homeostasis and to regulate rest and activity. Physiological activities controlled by the ANS such as blood pressure and sweating are generally unconscious and nonvoluntary. See Chapter 5, 'From 'Where' to 'What': The Functional Roles of Brain Regions'.

automatic process (au-to-MA-tic PRAH-ses): A highly practiced skill or habit that can be performed with minimal conscious involvement and voluntary effort. See Chapter 3, 'Working Assumptions'.

axon (AK-son): A long, slender branch of a nerve cell (neuron) that conducts electrical impulses away from the cell body. See Chapter 1, 'Some Starting Points', and Chapter 3, 'Introduction'.

Balint's syndrome (BA-lint-s SIN-drome): A brain disorder that is marked by simultanagnosia, the inability to perceive two or more objects at the same time. It may also include an inability to point to a target, and to shift gaze voluntarily. See Chapter 6, 'Brain Areas Necessary for Visual Awareness: Lesion Studies'.

Baron-Cohen, Simon (b. 1958): Autism researcher who proposed that young children develop a **theory of mind** capacity, composed of four skills: detection of intentions of others, detection of eye-direction, shared attention with others, and implicit knowledge about others. See Chapter 14, 'Overview'.

basal ganglia (BAY-zel GAN-glee-uh; from Latin *basis* = step, base; Latin for swelling or excrescence): A large cluster of sub-cortical structures just outside of each thalamus, involving

motor control, automaticity, cognition, emotions, and learning. See Chapter 5, 'Growing a Brain from the Bottom Up'.

behaviorism (bi-HAY-vyer-ism): A philosophy of psychology proposing that all things organisms do, including acting, thinking, and feeling, should be regarded as behaviors. See Chapter 1, 'The Return of Consciousness in the Sciences'.

beta waves (BAY-tuh WAYVZ; second letter of Greek alpha-bet): A band of irregular electromagnetic waveforms detected in the brain or on the scalp, and apparently reflecting the activity of large populations of neurons. The beta band has a frequency above 12 Hz and is associated with normal waking consciousness. Low-amplitude beta waves with multiple and varying frequencies often are associated with active, busy, or anxious thinking and active concentration. See Chapter 4, 'A Range of Useful Tools'.

binocular disparity (bih-NOC-u-ler dis-PAR-eh-tee; from Latin *bi-* = two; Latin *oculus* = eye; Latin *disparare* = to separate): The difference in perceived location of an object seen by the left and right eyes, resulting from the eyes' horizontal separation. The brain uses binocular disparity to obtain depth information from the retinal image in both eyes. See Chapter 6, 'Functional Organization of the Visual System'.

binocular rivalry (bih-NOC-u-ler RYE-vel-ree; from Latin *bi-* = two; Latin *oculus* = eye): The alternating perception that occurs when a different pattern is shown to each eye and the brain cannot fuse them into a single, coherent percept. Instead, awareness of each eye's input appears and disappears for a few seconds. See Chapter 6, 'Linking Brain Activity and Visual Experience', Chapter 8. See **bistable perception**.

bistable perception (BYE-STAY-bel per-SEP-shun; from Latin *bi-* = two): Sensory events that alternate between two perceptual interpretations. See Chapter 6, 'Linking Brain Activity and Visual Experience'.

blindsight (BLIND-site): A type of brain damage in which patients can report some visual events with no subjective sense of seeing them, due to impairment of the first cortical area of the visual system, area V1. See Chapter 6, 'Brain Areas Necessary for Visual Awareness: Lesion Studies'.

blood-brain barrier: A barrier between the bloodstream and the tissue of the brain, created by cells that line blood vessels in the brain. It allows the passage of small molecules like oxygen and glucose, while blocking larger molecules. See Chapter 16.

blood-oxygen-level-dependent (BOLD) activity (BLUD OKS-eh-gen LEV-el dee-PEN-dent ak-TI-vi-tee): A magnetically induced physical signal that reflects the flow of oxygen in specific regions of the brain. The BOLD signal is the physical source for functional magnetic resonance imaging. See Chapter 4.

brainstem (BRAYN-stem): The lower part of the brain, connecting to the spinal cord. All major motor and sensory systems pass through it, including the optic and auditory nerves. The brainstem also regulates cardiac and respiratory functions, and maintains conscious waking, slow-wave sleep

(SWS), and REM dreams. See Chapter 5, 'Growing a Brain from the Bottom Up'.

Broadbent, Donald (1926–1993): British cognitive psychologist who developed the influential concepts of selective attention and working memory. See Chapter 2, 'Limited and Large-Capacity Functions'.

Broca, Pierre-Paul (1824–1880): A French surgeon who studied a brain-damaged patient with expressive aphasia, the inability to speak, while being able to understand speech. After the patient's death he was able to conduct a post-mortem identifying the damaged region as the left inferior frontal gyrus, now called Broca's area. See Chapter 1, 'Some History, and Ongoing Debates'.

Broca's area (BRO-kas AIR-ee-a): The left inferior frontal gyrus, or its posterior segment, reported by Pierre-Paul Broca in 1861 to be responsible for the deficit of a patient who could not speak, but had preserved speech understanding. Other functions have since been attributed to Broca's area. See Chapter 1, 'Some History, and Ongoing Debates', and Chapter 7, 'Speech Perception'.

Brodmann's areas (BROD-mans AIR-ee-uh): About 100 cortical regions defined and numbered by German neurologist **Korbinian Brodmann**, originally based on the microscopic anatomy of **neurons** in different patches of the cortex. They are still widely used for cortical localization, and Brodmann's areas generally have distinctive functions. See Chapter 5, 'Introduction'.

Buber, Martin (1878–1965): An Austrian-born Jewish philosopher best known for his philosophy of 'I and Thou' dialogue, emphasizing the relationships between conscious persons rather than reducing others to objects. See Chapter 14, 'Overview'.

cell assemblies (SEL uh-SEM-blees): Also called Hebbian cell assemblies, these are active networks of related **neurons** representing some sensory input or similar event. According to Donald O. Hebb's 1949 hypothesis, 'neurons that fire together, wire together', so that simultaneous firing causes the **synaptic** links in a cell assembly to grow stronger. See **Hebbian learning**. See Chapter 3, 'Working Assumptions'.

Central Dogma of Molecular Biology, The: The hypothesis that genetic information flows in one direction only, from DNA to messenger RNA, and then to active proteins. The Central Dogma was first enunciated by Francis Crick in 1958, and has been modified by later discoveries showing numerous causal loops that operate in the reverse direction. However, DNA is still a tightly protected molecule that is rarely altered. However, its expression is constantly regulated – enabled or blocked by epigenetic events. See Chapters 15 and 16.

central executive (CEN-trel eks-EK-yoo-tiv; from Latin *centrum* = center): Brain processes for planning, decision making, abstract thinking, rule acquisition, initiating and inhibiting actions, resolving goal conflicts, and flexible control of attention. These functions relate to **working memory** and tend to involve the **frontal lobes**. See Chapter 2, 'Classical Working Memory' and 'The Central Executive'.

central nervous system (CNS; SEN-trel NER-vus SIS-tem; from Latin *centrum* = center; Latin *nervus* = sinew, nerve): The brain and spinal cord. All neurons outside of the CNS are considered to be the **peripheral nervous system** (PNS). See Chapter 5, 'Introduction'.

central sulcus (SEN-tral SUL-cus; from Latin *sulcus* = groove): Also called the central fissure, this fold in the **cerebral cortex** is a prominent landmark of the brain that separates the **parietal lobe** from the **frontal lobe** and the **primary motor cortex** from the **primary somatosensory cortex**. The central sulcus is a clear dividing line between the input- and output-related areas of cortex. See Chapter 1, 'Some Starting Points'.

cerebellum (ser-e-BEL-em; from the Latin word *cerebrum* = brain, *cerebellum* means 'little brain'): A major region of the brain located just below and to the rear of the occipital lobe of the cerebral cortex. The cerebellum plays an important role in the integration of sensory perception, fine motor control, and sensorimotor coordination. Recent evidence shows cognitive involvement as well. See Chapter 1, 'Some Starting Points', and Chapter 5, 'Introduction'.

cerebral cortex (suh-REE-bral KOR-teks; from Latin *cerebrum* = brain; Greek *cortex* = bark): The outer surface of the great cerebrum, the largest part of the human brain, divided into two symmetrical **cerebral hemispheres**. Most of the cortex has six distinctive cellular layers, containing cell bodies with a gray appearance. But its long-distance nerve cells send out axons to other parts of cortex, to thalamus, and to other brain regions, which become covered with white supportive cells (**myelin**). As a result, a vertical cut of the cortex appears to the naked eye to have a thin, gray outer layer and a white inner mass, called the 'gray matter' and 'white matter', respectively. The cerebral cortex plays a key role in sensory analysis, spatial location, speech perception and production, **memory**, **attention**, emotion, motivation, action planning, voluntary control, thought, **executive functions**, and **consciousness**. See Chapter 1, 'Some Starting Points', and Chapter 5, 'Growing a Brain from the Bottom Up'.

cerebrospinal fluid (CSF) (suh-ree-bro-SPEYE-nel floo-id; Latin *cerebrum* = brain): The internal circulation of the spine and brain. CSF allows for a protected flow of molecules and cells that is not exposed to the blood stream.

cerebrum (suh-REE-brum; Latin for *brain*): See **cerebral cortex**.

chromatin (KRO-muh-tin; Greek *chroma* = color): The substance of the chromosomes of each cell, including DNA, some RNA, proteins, and regulatory molecules that change the expression of DNA.

chunking: A way to make efficient use of short-term **memory** limitations by condensing large amounts of knowledge into a small symbolic units, rules, or regularities, called 'chunks'. In natural language nouns can be considered to be chunks, since they allow us to refer to large bodies of

knowledge by single words. See Chapter 2, 'Limited and Large-Capacity Functions'.

Churchland, Patricia (b. 1943): Canadian-American philosopher of mind who won a MacArthur prize in 1991. Churchland's 'neurophilosophy' argues that popular concepts of mind will need to be revised as we learn more about the underlying brain functions. See Chapter 1, Box 1.2.

cingulate cortex (SIN-gyu-lut KOR-teks; from Latin *cingulum* = belt; Latin *cortex* = bark): A part of the **cortex** on the medial (inner) surface of each hemisphere. It is involved in executive functions, the resolution of conflicting goals, and emotion.

classical conditioning (KLASS-ih-kel con-DI-shun-ing): Also called Pavlovian conditioning. A form of associative learning in which humans or animals learn that an arbitrary stimulus (such as a bell) signals the coming of a biological stimulus (such as food). I. P. Pavlov called these the conditioned stimulus (CS) and unconditioned stimulus (US). If the CS is repeatedly presented just before the US, an animal begins to produce a behavioral response to the CS. Pavlov's proposal that conditional reflexes are the basic unit of all human **learning** is no longer generally believed. However, classical conditioning is widely used in research and is thought to be relevant to learned anxiety disorders and food preferences. See Chapter 13, 'Introduction'.

cognitive neuroscience (KOG-ni-tiv NOOR-o-SI-ens; from Latin *cognoscere* = to know): An emerging integration of two previously separate fields of science, cognitive psychology and neuroscience. Most research in cognitive neuroscience makes use of psychological methods simultaneous with brain activity recording. See Chapter 1, 'Introduction'.

cognitive set (KOG-ni-tiv SET; from Latin *cogn* = to know): A state of mental preparedness for some event or action. See Chapter 12, 'A Closer Look at Frontal Lobe Function'.

computed tomography (kom-PYOO-ted tom-OG-reh-fee; from Latin *computare* = to consider; Greek *tomos* = slice; Greek *graphein* = writing): Abbreviated as CT. Physiological recordings in which a three-dimensional image of a body structure (such as the brain) is constructed by computer from a series of slice images. See Chapter 4, 'Introduction'.

confabulation (kon-fab-yoo-LAY-shen; from Latin *fabula* = story): A neurological symptom in which false memories or perceptions are reported with no intention to lie. See Chapter 9, 'Memories Are Made of This'.

connectionism (keh-NEK-shun-ism; from Latin *com-* + *nectere* = to bind together): The study of artificial or biologically based neural networks. See Chapter 3, 'How Neural Arrays Adapt and Learn'.

consciousness (KON-shes-ness; from Latin *con* = together; *scientia* = knowledge): Awareness, wakefulness. **Consciousness** implies being sensitive and responsive to the environment, in contrast to being asleep or in coma. Synonyms

include *explicit cognition* and *focal attention*. See Chapter 1, ‘Some History, and Ongoing Debates’ and ‘The Return of Consciousness in the Sciences’; and Chapter 8.

consolidation hypothesis (kon-SOL-ih-DAY-shun high-POTH-uh-sis): The process by which new memories are transformed into long-term **memory** traces. Memories may be stored in the same areas of the brain that support active moment-to-moment functions like perception and speech control. Consolidation may involve synaptic changes in such brain regions, which make active neuronal connections more efficient. See Chapter 2, ‘Consolidation of Short-Term Events into Long-Term Memory’.

contralateral (KON-tra-LAT-er-el; Latin for ‘against the side’): The opposite side of the body or brain. See Chapter 2, ‘Action’. See **ipsilateral**.

coronal (keh-RONE-el; from Latin *corona* = crown): A crown-shaped vertical slice of the brain that divides it into **anterior** and **posterior** halves. See Chapter 1, ‘Some Starting Points’.

corpus callosum (KOR-pus kal-OS-um; from Latin *corpus* = body; Latin *callosum* = tough): A massive fiber bridge between the right and left hemispheres, consisting of more than 100 neuronal axons. It appears white when cut, because the axons are covered by white **myelin** cells. See Chapter 1, ‘Some Starting Points’.

cortex (KOR-teks): See **cerebral cortex**.

cortical color blindness (KOR-ti-keL KUH-ler BLIND-ness): An inability to identify colors caused by damage to color-sensitive regions of the visual cortex. See Chapter 6, ‘Brain Areas Necessary for Visual Awareness: Lesion Studies’.

cortical column (KOR-ti-keL KAW-lum; from Greek *cort* = skin, husk; Latin *columna* = top): A barrel-shaped slice of the six surface layers of **cortex** that often contain closely related **neurons**. Columns are about 0.5 mm in diameter and 2.5 mm in depth. They may be clustered into **hypercolumns**, which may be part of even larger clusters. See Chapter 5, ‘Introduction’.

creole (KRAY-ole): A true language that children spontaneously evolve in multilingual communities. Creoles often are encountered in island communities where language communities overlap. ‘Creoles’ are contrasted with ‘pidgins’, which are dialects typically spoken by adults as a second language. Creoles are remarkable because they exhibit a full-fledged grammar, unlike pidgins. The spontaneity with which they arise suggests that human infants and children may be equipped with a biological language capacity with universal features. See Chapter 11, ‘The Nature of Language’ and Box 11.2.

Darwin, Charles (1809–1882): English naturalist who was among the first in modern times to make a persuasive case that all living species emerged from common ancestors over very long stretches of time, by ‘survival of the fittest’ and the most reproductively successful. Darwin also

published important observations about emotional expressions in humans and animals. See Chapter 1, ‘Some History, and Ongoing Debates’.

declarative memory (deh-KLAR-a-tiv MEM-ree; from Latin *declarare* = to make visible): The capacity to recall facts and beliefs. A kind of **explicit memory**. See Chapter 2, ‘Classical Working Memory’.

déjà vu (DAY-zha VOO; French for ‘already seen’): A feeling that one has lived through the present moment before. See Chapter 9, ‘Varieties of Memory’ and Box 9.3.

delta waves (DEL-tuh WAYVZ; fourth letter of Greek alphabet): A band of slow, high-amplitude electromagnetic waveforms associated with deep sleep, and recorded in the brain or on the scalp, apparently reflecting large populations of neurons. Delta generally is considered to be less than 2.5 Hz. It coexists with waking EEG as well, but becomes visible in the raw (unprocessed) EEG only when delta predominates in sleep and drowsy states. See Chapter 4, ‘A Range of Useful Tools’.

dendrite (DEN-drite; from Greek *dendron* = tree): One of numerous thin, branched micron-level tubes extending from the cell body of a **neuron**. Dendrites typically receive synaptic stimulation from other neurons, and therefore serve as the input branches of the neuron. See Chapter 3, ‘Introduction’.

Descartes, René (1596–1650): A French philosopher, mathematician, scientist, and writer who spent most of his adult life in the Dutch Republic. Descartes has been dubbed the ‘Father of Modern Philosophy’ and was also a careful student of the brain. He often is considered the originator of modern mind/body philosophy. See Chapter 1, ‘Some History, and Ongoing Debates’.

developmental cognitive neuroscience (deh-vel-op-MEN-tel COG-ni-tiv NUR-o-si-ens): The study of the normal growth of the brain and its mental capacities. See Chapter 15, ‘Introduction’.

diencephalons (die-en-SEF-a-lon; from Greek *dia* = through; *enkephalos* = brain): The part of the brain that contains the **thalamus**, **hypothalamus**, and the posterior half of the **pituitary gland**.

diffusion tractography (di-FYOO-zhen trak-TOH-greh-fee; from Latin *diffusus* = scatter; *trahere* = to pull; Greek *graphein* = writing): A brain imaging technique that tracks the diffusion of water molecules in order to trace the major neuronal pathways of the brain. See Chapter 4 and the Appendix.

discourse (DIS-kors): A style of language usage in a community, often taken to reflect a particular political slant. See Chapter 11, ‘Introduction’.

domain specificity (do-MANE spes-i-FIS-ih-tee): Functional specificity of brain regions or mechanisms. The idea that each cognitive function may have its own region or network of brain regions, rather than general-purpose brain mechanisms with multiple cognitive functions. See Chapter 12, ‘A Closer Look at Frontal Lobe Function’.

dopamine (DOH-puh-meen): A major neuromodulator and neurotransmitter that is produced in several different parts of the brain, including the substantia nigra and ventral tegmental area. Dopamine has numerous functions, including voluntary movement control, reward, and inhibition of lactation (milk production) in females, sleep, mood, attention, and learning.

dorsal (DOR-sel; from *dorsum* = back): The upper part of a brain structure, also called **superior**.

dorsolateral syndrome (dor-so-LAT-er-el SIN-drome; from Latin *dorsum* = back; *latus* = side; *frons* = forehead): Deficits caused by damage to the **dorsolateral prefrontal cortex**, such as ‘flat affect’ (lack of emotion) and an impaired ability to switch to and initiate new actions. See Chapter 12, ‘Frontal Lobe Dysfunction’.

dorsolateral prefrontal cortex (DOR-so-LAT-er-el pree-FRON-tal KOR-teks; from Latin *dorsum* = back; *latus* = side; *pre* = in front of; *frons* = the forehead; Greek *cortex* = bark): Prefrontal region involved in motor planning, executive control, self-regulation, emotion, and **working memory**. See Chapter 2, ‘The Central Executive’.

dynamic causal modeling (die-NAM-ic KOS-el MO-del-ing; from Greek *dynamikos* = powerful; Latin *causa* = cause; Latin *modulus* = small measure): A method for interpreting brain data, such as **functional magnetic resonance imaging** (fMRI), that helps to interpret causal relationships among brain activities during a specified task. See Chapter 4, ‘Correlation and Causation’.

echolalia (eh-ko-LAY-lee-eh; Greek *ēchō* = to repeat; *laliá* = babbling): Constant and uncontrollable imitation of the speech of others. Echolalia may be seen in autism, Tourette syndrome, **aphasia**, developmental disability, schizophrenia, Asperger syndrome, Alzheimer’s disease, and other conditions. See Chapter 12, ‘Frontal Lobe Dysfunction’.

echopraxia (eh-ko-PRAK-see-eh; from Greek *ēchō* = to repeat; *praxis* = action): A neurological symptom involving repeated, involuntary imitation of the movements of another person. See Chapter 12, ‘Frontal Lobe Dysfunction’.

Edelman, Gerald M. (b. 1929). American immunologist and neurobiologist who won the Nobel Prize for his work on the structure of antibody molecules. Edelman developed the theoretical framework of Neural Darwinism, which applies Darwinian selectionist principles to the brain, in contrast to the instructionist principles of conventional computers. See Chapter 3 and Chapter 16.

electroencephalography (EEG; eh-LEK-tro-en-sef-eh-LOG-reh-fee; from Greek *ēlektron* = sunlight; *en-* + *kephalē* = in the head; *graphein* = writing): Electrical activity that typically is recorded on the scalp and sometimes on the surface of the **cortex**, reflecting the electromagnetic field of large numbers of active neurons. See Chapter 4, ‘A Range of Useful Tools’, and the appendix.

empathy (EM-path-ee; from Greek *empathēia* = passion): The capability to share one’s feelings and understand another person’s. See Chapter 14, ‘Overview’.

enzyme (EN-zime; Greek, *en-* + *zyme* = yeast): Molecules that facilitate the rate of chemical reactions.

epigenesis (ep-ih-GEN-eh-sis; from Greek *epi* = after; Greek *genesis* = birth, origin): Non-DNA factors that shape cells during gestation (pregnancy) and after birth. Contrasted with the classical Central Dogma of molecular biology, in which DNA is recoded into transfer RNA, which ends in the production of proteins for the structure and functions of all cells. Epigenesis implies a flow of causality in the opposite direction. For example, numerous physiological and environmental factors can influence whether specific genes (DNA) are expressed or not. DNA is the primary molecule that encodes phenotypes, passing the plan for a species from one generation to the next. But non-DNA factors can influence the activation and silencing of DNA, the on/off switches. See Chapters 15 and 16.

epigenetics (ep-ih-juh-NET-iks; Greek *epi-* = after; *genesis* = birth, origin): Changes in gene expression caused by other mechanisms than the direct expression of DNA via messenger RNA and their resulting proteins. See Chapters 15 and 16.

episodic memory (ep-i-SOD-ic MEM-ree; from Greek *episeidos* = coming in besides): **Memory** for conscious experiences, especially those that can be explicitly recalled, such as times, places, events, associated emotions, and other contextual knowledge. The formation of new episodic memories requires the **medial temporal lobe**, especially the **hippocampal region** in combination with the **cerebral cortex**. See Chapters 2 and 9.

evoked potential (**EP**; ee-VOKD puh-TEN-shul; from Latin *evocare* = to call forth; *potentia* = power): Also called *event-related potential* (ERP). A quite stereotypical electrical voltage pattern obtained from the brain, after averaging a time-locked voltage to a stimulus or other known event. Traditionally, the **EP** was obtained by averaging the stimulus-locked **EEG** over numerous trials. Though the exact brain sources of **EPs** are still debated, they are highly sensitive to cognitive and emotional variables. See Chapter 4, ‘A Range of Useful Tools’.

excitotoxicity (ek-SEYE-toh-tok-SIS-ih-tee; Latin, *excitare* = to arouse; *toxicum* = poison). Neural damage caused by an excess of glutamate, the usually excitatory neurotransmitter. Excitotoxicity is believed to be a major cause of brain degeneration and post-injury damage. See Chapter 16.

executive attention (ek-ZEK-u-tiv a-TEN-shun): Also called **voluntary**, **goal-directed**, or **top-down attention**. The act of voluntarily focusing on one stream of conscious events while ignoring others. Also see **selective attention**, **stimulus-driven attention**. See Chapter 8.

executive function (ek-ZEK-u-tiv FUNK-shun): Also called **executive control** or **frontal lobe function**. Capacities such as

planning, cognitive flexibility, voluntary action, abstract thinking, rule acquisition, initiating correct actions and inhibiting incorrect ones, impulse control, and emotional regulation. See Chapter 12, 'Introduction'.

explicit memory (eks-PLI-sit MEM-ree; from Latin *explicitus* = clear): A type of **memory** involving conscious, intentional recollection of stored experiences, and knowledge. See **implicit memory**, **implicit learning**. See Chapter 2, 'Classical Working Memory', and Chapter 9, 'Introduction'.

extinction (eks-TINK-shun): The process by which learned behaviors cease to be reinforced and therefore decline in frequency. In **parietal neglect**, after damage to the right parietal lobe, the ability of stimuli presented to the left side of the visual field to cancel those presented to the right side. See Chapter 13, 'The Fear System'.

Fechner, Gustav (1801–1887): German physicist, mathematician, and pioneer in psychophysics. Fechner claimed to have solved the mind-body controversy when he demonstrated a general logarithmic relationship between subjective sensory intensity and physical stimulus intensity across many different sensory modalities. See Chapter 1, 'Some History, and Ongoing Debates'.

feedback (FEED-bak): 1. In goal-guided systems, a signal from the environment indicating the degree of error in achieving the goal. 2. In neuroscience and psychology, an environmental signal reflecting some neuronal event. This kind of neurofeedback often allows people to learn to control otherwise spontaneous neuronal activities. 3. In neural networks, a flow of information returning an output signal to the input layer of the network. Some theorists make a strong distinction between **feedback** and **re-entrant** signaling in the **thalamo-cortical** system of the brain. See **Neural Darwinism**. Chapters 3 and 6, 'Theories of Visual Consciousness: Where Does It Happen?'

feedforward (feed-FOR-werd): 1. Signal passing from a simpler to a more complex stage of processing. 2. In sensorimotor guidance, preparing an internal action trajectory to obtain more precise feedback when the action is executed. This strategy is used in fast movement control in birds and humans, and even in machines like aerodynamically unstable jet planes. 3. In neural networks, passing information from earlier to later layers of the network.

fetal alcohol syndrome (FEE-tel AL-ko-hol SIN-drum): (**FAS**). Brain damage in a fetus due to the mother's alcohol consumption, a major health risk. See Chapter 15, 'Prenatal Development: From Blastocyst to Baby'.

first-person perspective (FERST PER-son per-SPEK-tiv): The conscious viewpoint of the self or 'I'. See Chapter 14, 'Overview'.

flanker task (FLANK-er TASK): A tool for studying visual attention, in which the subject is asked to respond as quickly as possible to a target at the center of gaze, or one located off-center by a known distance. The target is flanked by

distracting stimuli, such as arrows or letters. The flanker task permits quantitative assessment of the subject's speed and accuracy in shifting attention to an expected or unexpected position of the target. Moving attention in an unexpected direction is taken to require **executive attention**, since it must override the prepared, expected shift. Flanker tasks generally require subjects to avoid voluntary eye movements, so that any change in accuracy or speed in response to a target can be attributed to **implicit** shifts of attention. See Chapter 8.

flash suppression (FLASH suh-PRESH-en): A variant of the binocular rivalry task, in which an image presented to one eye is suppressed by a flashed image to the other eye. See Chapter 8.

Fourier analysis (FOOR-ee-ay uh-NAL-a-sis): Named after French mathematician and physicist Joseph Fourier, who showed that any complex function can be decomposed into a finite set of sine and cosine functions. In music, for example, this implies that any complex sound can be decomposed into a set of pure tones (sine waves). Fourier analysis is routinely applied to decompose EEG and other complex brain signals into frequency bands. See Chapter 4, 'A Range of Useful Tools'.

Fragile X syndrome: A genetic disorder with a range of physical, cognitive, emotional, and behavioral deficits. The most common cause of mental retardation. See Chapter 16.

Freud, Sigmund (1856–1939): Austrian physician and neurologist who founded the psychoanalytic school of psychology, and a highly influential cultural figure. Freud is best known for his theories of the unconscious mind and for creating the clinical practice of psychoanalysis. He was also an early neurological researcher who developed an early neural network model and discovered a new chemical stain – gold chloride – which allowed certain brainstem neurons to stand out clearly under the microscope. Although many of Freud's ideas have fallen from favor, some brain phenomena, like the role of the frontal lobes in regulating emotional impulses and goal-conflicts, are broadly consistent with his point of view. See Chapter 1, 'Some History, and Ongoing Debates'.

frontal lobe (FRON-tal lobe): An large region of cortex located at the front of each cerebral hemisphere and positioned forward of the **parietal lobes** and above and in front of the **temporal lobes**. The executive functions of the frontal lobes include the ability to anticipate the consequences of actions, to plan and make decisions, to speak, to override inappropriate impulses and resolve conflicting goals, to understand the mental states of others, and to hold information in working memory. See Chapter 1, 'Some History, and Ongoing Debates', and Chapter 5, 'Introduction'.

functional fixedness (FUNK-shun-el FIKS-ed-ness): A cognitive set that tends to block a person from novel ways of acting, perceiving, or solving problems. See Chapter 10, 'Explicit Problem-Solving'.

functional magnetic resonance imaging (**fMRI**; FUNK-shun-el mag-NET-ic REZ-nence IH-ma-jing): A type of

specialized **magnetic resonance imaging (MRI)** that measures local blood oxygenation related to **neural** activity in specific parts of the brain. fMRI helped to make cognitive neuroscience possible. See Chapter 4, 'Introduction', 'fMRI and PET: Indirect Signals for Neural Activity'.

functional redundancy (FUNK-shun-el ree-DUN-den-see): Built-in backup functions in a system to prevent the complete failure of critical functions. For example, mammals have two lungs so that if one fails, the organism still has one lung to breathe. The brain has multiple redundant capabilities. See Chapter 3, 'Functional Redundancy'.

fusiform face area (FFA; FYOO-ze-form; from Latin *fuscus* = spindle, after its shape): A specialized region in the **medial temporal lobe** that responds selectively to visual faces compared to other objects. See Chapter 6, 'Functional Organization of the Visual System'.

Gage, Phineas (1823–1860): A historic brain damage patient, whose railroad accident demonstrated remarkable spared cognitive capacities in spite of severe damage to the frontal lobes. Gage was a railroad foreman who had a two-foot-long thin tamping iron shot through the upper orbit of the left eye and out through the medial scalp, when an unstable dynamite charge exploded unexpectedly. Although Gage appeared to have no loss of perception, motor control, or speech, his personality changed in ways that have come to typify frontal lobe damage, especially a major loss of impulse control and long-term motivation. See Chapters 2 and 12.

gamma-aminobutyric acid (GABA; GAM-uh uh-mee-no-byoo-TEER-ic ASS-id): The major inhibitory **neurotransmitter** in the central nervous system. It plays an important role in regulating neuronal and behavioral excitability, including sleep. GABA is needed for brain oscillations and for the regulation of muscle tone. See Chapter 16.

gamma waves (GAM-a WAYVZ; third letter of Greek alphabet): A band of fast, low-amplitude electromagnetic waveforms associated with wakefulness and active thinking, and recorded in the brain or on the scalp, apparently reflecting the activities of large populations of neurons. The gamma band is thought to be centered near 40 Hz, ranging from 25 to 60 Hz. However, higher frequency waves are sometimes labeled gamma as well. Gamma is thought to reflect regional connectivity in the service of current tasks. See Chapter 4, 'A Range of Useful Tools'.

ganglion (GAN-gee-on; Latin for swelling): A large cluster of **neurons**. The major subcortical organs may be considered to be ganglia, such as the **basal ganglia**. They are often very large structures, and have multiple functions. They are typically composed of subdivisions, which themselves are often layered and folded arrays of nerve cells. See Chapter 5, 'From 'Where' to 'What': The Functional Roles of Brain Regions'.

gap junction (also called electrical synapse): A direct membrane-to-membrane junction between two neurons or glial cells. Gap junctions once were thought to be rare, but now are believed to exist throughout the brain, especially in **GABA-ergic** connections in the top layer of cortex.

genome (JEE-nome; Greek, *genea* = generation, race): The full genetic blueprint specifies a biological species. See Chapter 16.

genotype (JEE-no-tipe): A genome, often contrasted with the *phenotype* for a given species, which is the physiological expression of the genetic code. See Chapter 16.

gestalt (gesh-TALT; German for *form*): 1. A perceptual stimulus that cannot be reduced to simple subcomponents. 2. A branch of psychology based on the German concept of *Gestalt*, often summed up with the slogan that 'The whole is more than the sum of its parts'. Gestalt psychology has profoundly influenced the study of perception. See Chapter 6, 'Introduction'.

glial cell (GLEE-el SEL; from Greek *glia* = glue): Non-neuronal cells in the brain that support neurons, maintain neurochemical homeostasis, form protective **myelin sheath** around neurons, and process information. See Chapter 15, 'Prenatal Development: From Blastocyst to Baby'.

glutamate (Glu; GLOO-teh-mayt; from Latin *gluten* = glue): A molecule related to glutamic acid that is the most abundant excitatory **neurotransmitter** in the brain. See **gamma-aminobutyric acid (GABA)**. See Chapters 3 and 16.

gray matter: The outer layers of the **cerebral cortex**, as seen with the naked eye. Gray matter contains the cell bodies of tens of billions of **neurons** that send white-covered **axons** in many directions below the cortical mantle. See **white matter**. See Chapter 5, 'Introduction'.

head-related transfer function (HRTF; HED reh-LAY-ted TRANS-fer FUNC-shun): A method for computing the location of sounds in auditory space. See Chapter 7, 'Functional Mapping of Auditory Processing'.

Hebbian learning (HEB-ee-en LUR-ning): According to Donald O. Hebb, 'neurons that fire together, wire together'. That is, two neurons strengthen their **synaptic** links if they are active at the same moment. This process forms **cell assemblies**. Introduced by Donald Hebb in 1949, it is also called Hebb's rule. See Chapter 3, 'How Neural Arrays Adapt and Learn'.

Helmoltz, Hermann von (1821–1894): German physician, physicist, and sensory scientist. His works on vision and audition are still read, but his best-known contribution was demonstrating the physical law of conservation of energy using electrical stimulation of dissected frog legs. Helmholtz was one of the first to propose that the visual system makes 'unconscious inferences' that go beyond the raw light input to the eyes, a controversial idea in his time that has become widely accepted. See Chapter 1, 'Some History, and Ongoing Debates'.

hemispheric lateralization (hem-is-FEER-ik lat-er-al-ih-ZAY-shun; from Greek *hēmi-* (half) + *sphairion* = sphere; and Latin *lateralis* = side): The degree to which certain brain functions are performed primarily by one **cerebral** hemisphere, the most prominent being speech production on the left side for most people. See Chapters 5, 9, and 11.

hemodynamics (HEE-mo-dye-NAM-ics; from *hema* = blood; *dynamis* = force): The study of blood flow changes, particularly in the brain, as an index of local neural activity. See Chapters 1 and 4.

hippocampus (hip-o-KAM-pes; Greek seahorse, from *hippos* = horse, *kampos* = sea monster): In the human brain, the hippocampi are looped structures in each of the two **medial temporal lobes**. The hippocampi are part of the **limbic system** and play basic roles in encoding and retrieving **episodic** and **semantic memories** and in spatial navigation. See Chapter 2, 'Classical Working Memory'.

histogenesis (HIS-to-gen-eh-sis; from Greek *histos* = mast, loom, beam, web; Greek *gignesthai* = to be born): The formation of specific cells from less differentiated progenitor cells. See Chapter 15, 'Prenatal Development: From Blastocyst to Baby'.

homeobox (Hox) (HO-mee-oh-boks; Greek *homos* = same): DNA segments that regulate body plans in animals and plants. Hox genes typically regulate other genes to have their effects.

homunculus (ho-MUN-cue-lus; Latin = little man): The distorted human body maps in the **primary somatosensory cortex** (the sensory homunculus) and in the **primary motor cortex** (the motor homunculus). The lips, hands, feet, and sex organs have more sensory neurons than other parts of the body, so the homunculus has correspondingly distorted large lips, hands, feet, and genitals. Each hemisphere contains a sensory and motor homunculus of the opposite side of the body. These body maps were discovered by neurosurgeon Wilder Penfield at the University of Montreal in the 1950s and 1960s. See Chapter 5, 'From 'Where' to 'What': The Functional Roles of Brain Regions'.

hydranencephaly (hi-dran-en-SEF-uh-lee; Greek, *hydr-* = water; *enkephalon* = in the head): A fetal disorder involving severe damage to the brain, including failure of the cortex to develop normally; the missing tissue is replaced by the watery cerebrospinal fluid. Hydranencephaly is more severe than hydrocephalus, in which brain development is more complete, though there is a build-up of cerebrospinal fluid in the ventricles. See Chapter 16.

hypercolumn (HEYE-per CAW-lum; from Greek *hyper* = above; Latin *columna* = top): A cluster of **columns** of **cortex** that often contain closely related **neurons**. See Chapter 5, 'Introduction'.

hypothalamus (hie-po-THAL-a-mus; from Latin *hypo* = below; Greek *thalamos* = chamber): The major neuroendocrine organ of each side the brain, with vital roles in the regulation of blood nutrients, motivation, appetite control, and other major life functions. The hypothalamus is located below each **thalamus** just above the **brainstem**. It is closely related to the **pituitary** and **pineal glands**. See Chapter 5, 'Growing a Brain from the Bottom Up'.

immediate memory (ih-MEE-dee-et MEM-er-ee): Also called short-term **memory**. The ability to recall something for

10 to 30 seconds without rehearsal. **Working memory** and **sensory memories** can be seen as specific kinds of immediate memory. See Chapter 2, 'Classical Working Memory'.

implicit memory (im-PLI-sit MEM-er-ee; from Latin *implicitus* = obscure): Unconscious **memory**, which may arise from conscious or unconscious events. See Chapter 2, 'Classical Working Memory', Chapter 9, 'Introduction'.

inattentive blindness (in-uh-TEN-shun-el BLIND-ness): A reliable experimental phenomenon in which one is not able to see things that are normally clearly visible. See Chapter 8.

inference (IN-fer-ens): Drawing a conclusion based on knowledge rather than direct observation. See Chapter 1, 'Some Starting Points'.

inferior (in-FEER-ee-er; from Latin *inferus* = lower): Below.

inhibitory control (in-HIB-ih-tor-ee; from Latin *in-* = not; Latin *habere* = to have, to consider): Nerve impulses that act to damp down or stop a particular activity or response. See Chapter 12.

insula (IN-soo-la; Latin for island): A structure that is hidden in and underneath the **lateral sulcus**, covered up by the **temporal** and **parietal lobes**, and therefore appears as an island when the covering tissues are gently pulled away. The insula is involved in 'gut feelings', such as the sense of nausea and disgust, and possibly in emotional feelings and cravings. See Chapter 5, 'From 'Where' to 'What': The Functional Roles of Brain Regions'.

intentionality (in-ten-shen-AL-ih-tee): The 'aboutness' of mental events, their ability to represent aspects of the world. Distinguished from *intention* as a mental goal. See Chapter 14, 'Overview'.

interaural level difference (in-ter-OR-el; from Latin *inter-* = between; *auris* = ear): A method of sound localization in which the brain detects the small difference in loudness between the two ears that occurs when a sound travels toward the head from an angle. See Chapter 7, 'Functional Mapping of Auditory Processing'.

interaural-time-difference (in-ter-OR-el): A method of **sound localization** in which the brain detects the split-second delay between the time when sound from a lateral source reaches the near ear and when it reaches the far ear. See Chapter 7, 'Functional Mapping of Auditory Processing'.

intersubjectivity (IN-ter-sub-jek-TIV-ih-tee): The sharing of subjective experiences, such as infants' ability to point to and name a toy and receive validation from an adult. A crucial aspect of social cognition and language learning. See Chapter 14, 'Overview'.

intonation contour (in-toh-NAY-shun kon-TOOR): The 'melody' or sing-song of normal speech. In English and other languages, questions typically are given a different intonation contour compared with affirmative statements. See Chapter 11, 'The Sounds of Spoken Language'.

ionotropic receptor (eye-ono-TROP-ik ree-SEP-ter; Greek, *ion* = going; *tropos* = direction): A group of membrane receptor channels for charged particles like Ca²⁺, Cl⁻, and Na⁺. Ionotropic receptors may be opened or closed by **neurotransmitters**. Also called ligand-gated ion channels, or channel-linked receptors.

ipsilateral (IP-si-LAT-er-al; from Latin *ipse* = self; *latus* = side): On the same side of the body. See **contralateral**. See Chapter 2, 'Action'.

James, William (1842–1910): American psychologist and philosopher. James summarized the 19th century's studies of the human mind and brain. His **Briefer Psychology** (1893) was widely used as an introductory text in psychology well into the 1920s. James also influenced Western stream of consciousness literature, educational psychology, and the study of religious experience and mysticism. In philosophy he is considered a major exponent of pragmatism, and was a source for European phenomenology. He was the brother of novelist Henry James and of diarist Alice James. See Chapter 1, 'Some History, and Ongoing Debates'.

lateral (LAT-er-al; from Latin *lateralis* = side): On the side(s) of the brain. See Chapter 1, 'Some Starting Points'.

lateral geniculate nucleus (LGN; LAT-er-el jen-ik-yoo-let NOO-klee-us; from Latin *latus* = side; *genu* = knee-shaped; Latin *nux* = nut): A nucleus consisting of 'knee-shaped' layers of cells in the thalamus. It is the primary relay center between the **retina** of the eye and the **primary visual cortex** (Area V1). See Chapter 6, 'Functional Organization of the Visual System'.

lateral inhibition (LAT-er-el in-hi-BI-shun; from Latin *latus* = side; Latin *inhibitus* = restrain): The capacity of a **neuron** to reduce the activity of its neighboring cells in the same layer of neurons. See Chapter 3, 'Working Assumptions'.

lateral occipital complex (LOC; LAT-er-el ox-SIP-it-al KOM-pleks; from Latin *latus* = side; Latin *occiput* = rear most part of the skull): A region on the side of the **occipital lobe** that has a general role in visual object recognition. See Chapter 6, 'Functional Organization of the Visual System'.

lateral sulcus (LAT-er-al SUL-cus; from Latin *latus* = side; *sulcus* = groove): Also called Sylvian fissure or lateral fissure. This prominent 'valley' divides the **temporal lobe** from the **frontal** and **parietal lobes**. See Chapter 1, 'Some Starting Points'.

L-dopa (el-DOH-puh; L = levorotatory, the leftward turning molecule; dopa = dihydroxyphenylalanine): The first medical dopamine agonist used to help Parkinson's patients by stimulating the production of dopamine in the substantia nigra. L-dopa is a natural precursor molecule in the synthesis of dopamine.

lexical identification (LEKS-ih-kul eye-den-tih-fih-KAY-shun; from Greek *lexis* = word): The process of assigning words to speech sounds. See Chapter 11, 'Introduction'.

lexicon (LEKS-ih-con; from Greek *lexis* = word): The vocabulary of a language. See Chapter 11, 'Introduction'.

limbic system (LIM-bik sis-tem; from Latin *limbus* = border): An ancient set of brain structures involved in emotion, memory, olfaction, and action control, including the **hippocampus**, **amygdala**, **thalamus**, **hypothalamus**, and **cingulate gyrus**. The limbic system is interwoven with the endocrine system and **autonomic nervous system**. See Chapter 13, 'Introduction'.

long-term depression (LTD; LONG TERM de-PRE-shun; from Latin *deprimere* = to press down): A lasting decrease in the strength of a **synapse**. Along with **long-term potentiation** (LTP), LTD is thought to be a synaptic basis for **learning** and long-term **memory**. See Chapter 3, 'How Neural Arrays Adapt and Learn'.

long-term potentiation (LTP; LONG TERM puh-ten-shee-AY-shun; from Latin *potentia* = power): A long-lasting strengthening of a synaptic link. Along with LTD, LTP is thought to be the synaptic basis of **learning** and long-term **memory**. See Chapter 3, 'How Neural Arrays Adapt and Learn'.

longitudinal fissure (lon-gi-TOOD-in-al FISH-er; from Latin *fissus* = crack, opening): The deep valley that divides the right and left hemispheres of the vertebrate brain. See Chapter 1, 'Some Starting Points'.

magnetic resonance imaging (MRI; mag-NET-ik REZ-nence IH-ma-jing; Latin *resonare* = to sound; *imago* = imitation): Based on the spin resonance of atomic nuclei, MRI is a technique used to visualize the internal structures of the body, including the brain. **Functional MRI** (fMRI) records brain activity and is often superimposed on the structural brain image obtained via MRI. See Chapter 4, 'Introduction'.

magnetoencephalography (MEG; mag-NET-o-en-sef-eh-LOG-gra-fee; Greek *en-* + *kephalē* = in the head; *graphein* = writing): An imaging technique based on the magnetic fields produced by brain activity. MEG is silent and noninvasive and has good temporal and spatial resolution. See Chapter 4, 'A Range of Useful Tools', and the appendix.

medial (MEE-dee-al): Toward the midline of the body. **mid-sagittal**. See Chapter 1, 'Some Starting Points'.

medial temporal lobe (MTL; MEE-dee-el TEM-per-el LOBE): The bottom aspect of the **temporal lobes**, which are arranged symmetrically around the midline, and contain evolutionarily ancient olfactory structures, memory encoding and recall, and emotional functions. See Chapter 5, 'From 'Where' to 'What': The Functional Roles of Brain Regions'.

memory (MEM-ree, MEM-eh-ree; from Latin *memor* = mindful): A lasting brain representation that is reflected in thinking, experience, or behavior. See Chapter 9.

mental flexibility (MEN-tel fleks-ih-BIL-ih-tee; from Latin *mens* = mind; Latin *flexus* = bent; Latin *-ibilis*, from *-bilis* = capable or worthy of): Also called ability to shift **cognitive set**. The capacity to respond rapidly to unanticipated environmental contingencies. See Chapter 12, 'A Closer Look at Frontal Lobe Function'.

mental rigidity (MEN-tel rih-GID-ih-tee; from Latin *mens* = mind; Latin *rigidus* = stiff): The inability to respond rapidly to unanticipated environmental contingencies, or shift **cognitive set**. Profound forms of mental rigidity produce obsessive-compulsive disorder. **Frontal lobe** damage often produces extreme mental rigidity. See Chapter 12, 'Frontal Lobe Dysfunction'.

mentalize (MEN-tel-ize; from Latin *mens* = mind): The ability to understand the self and others, not just as sensory objects but also as subjective beings with mental states. See Chapter 14, 'Overview'.

metabotropic receptor (meh-tab-oh-TROP-ik ree-SEP-ter; Greek, *metabole* = change; *tropos* = direction). Neuronal receptors that make use of the existing metabolic machinery of the cell to activate post-synaptic signaling. Contrasted with ionotropic receptors, which utilized ion channels in the cell membrane.

metacognition (MET-a-cog-NI-shen; from Greek *meta* = above; Latin *cognere* = to know): Knowing about cognition. Self-knowledge about memory, perception, or voluntary control. See Chapter 8.

midsagittal (mid-SAJ-i-tal; from Latin *sagitta* = arrow): **medial**. The midline plane of section, going from the nose to the middle of the back of the head. See Chapter 1, 'Some Starting Points'.

mind (from Greek *menos* = spirit): Those aspects of intellect and **consciousness** manifested in thought, perception, **memory**, emotion, will, and imagination, including all of the brain's conscious and unconscious cognitive processes. See Chapter 1, 'Some History, and Ongoing Debates'.

mind-reading (from Greek *menos* = spirit): The attempt to attune one's own actions to the minds of others. Most people are not accurate mind-readers in most circumstances. See Chapter 14, 'Overview'.

mirror neuron (MEER-er NUR-on or NYOO-ron; from Greek *neuron* = sinew, nerve): A neuron theorized to fire both when an animal performs an action and when it observes the same action performed by another. Large populations of mirror neurons have been found in primates and are believed to exist in other species, including birds. In humans, brain activity consistent with mirror neurons has been found in the premotor **cortex** and the **inferior parietal cortex**, however there is significant debate in the field regarding these findings. See Chapter 14.

mirror neuron system (MEER-er NUR-on or NYOO-ron SIS-tem; from Greek *neuron* = sinew, nerve): The presumed network of **mirror neurons** in the human brain, which is believed to be needed for social cognition. See Chapter 14.

mitochondrion (MEYE-toh-KON-dree-on; Greek *mitos* = thread, *chondrion* = grain): Plural, mitochondria. The energy-producing organelle in most animal cells. Mitochondria are believed to originate in blue-green algae that migrated into animal cells and established a mutual dependence or symbiosis.

Mitochondria are the chief source of the energy molecule ATP (adenosine triphosphate), and are indispensable for life in animals. They have their own nuclei with DNA, but much of their DNA has migrated to the nucleus of the host cell. Because energy production is a fundamental life process, the metabolic machinery of mitochondria has also been recruited for other functions like neuronal signaling. See Chapter 16.

module theory (MAH-jul THEE-eh-ree or THIR-ee; from Latin *modulus* = little measure; Greek *theōria* = contemplation): A type of theory that postulates that different brain functions may be localized in different regions or networks of the brain. See Chapter 14, 'Overview'.

morpheme (MOR-feem; from Greek *morphē* = form): The smallest linguistic unit that can convey meaningful information by itself. In English, prefixes and suffixes are considered to be morphemes (e.g., 'pre-' and 'post-'). See Chapter 11, 'Introduction'.

motion blindness (MO-shun BLIND-nes): A symptom caused by injury to brain regions needed for motion perception, such as **area MT** of the visual cortex, resulting in an inability to perceive visual motion. See Chapter 6, 'Brain Areas Necessary for Visual Awareness: Lesion Studies'.

multistable perception (MUL-tee-STAY-bel per-SEP-shun): Alternating visual perceptions of an ambiguous stimulus. See Chapter 6, 'Linking Brain Activity and Visual Experience'.

myelin (MY-e-lin; from Latin *myel* = marrow): A sheath of glial cells, called the myelin sheath, surrounding the **axons** of many **neurons**. Myelinated axons appear **white**, hence the '**white matter**' of the visible brain. See Chapters 1 and 3.

near infrared spectroscopy (NIRS; NEER in-fra-RED spek-TROS-kop-ee; from Latin *infra* = below, within; Greek *erythros* = red): A method of measuring light waves below the color red in the wavelength spectrum (about 800 nm to 2500 nm). It is used to measure blood hemoglobin as an index of regional brain activity. See Chapter 15, 'Developing Mind and Brain'.

neglect (nuh-GLEKT): A type of brain damage to the right parietal lobe, in which the patient fails to consciously perceive or attend to the left side of objects or scenes. See Chapter 6, 'Brain Areas Necessary for Visual Awareness: Lesion Studies'.

neocortex (NEE-o-COR-tex; from Latin *neo* = new; Greek *cort* = bark): The largest and most visible part of the human cerebral cortex. It is the 'new' cortex from an evolutionary point of view, as contrasted with the 'old' cortex of the **medial temporal lobe**, **hippocampus**, and olfactory brain. See Chapter 1, 'Some History, and Ongoing Debates'.

neon color spreading (NEE-on CAW-ler SPRED-ing): A perceptual illusion in which white space appears to be tinted by proximity to colored and black lines. See Chapter 6, 'Linking Brain Activity and Visual Experience'.

Neural Darwinism (NUR-el DAR-win-izm; from Greek *neuron* = nerve): A theory proposed by neuroscientist Gerald

Edelman that suggests that neurons develop and make connections following Darwinian principles. In biological evolution, species adapt by reproduction, mutations leading to diverse forms, and selection among the resulting repertoire of slightly different organisms. Neural Darwinism suggests that brains develop in similar fashion, both in the reproduction, variation, and selection of developing neurons, and in a later stage, in the Darwinian selection of synaptic connections. Brains are said to be *selectionist* rather than *instructionist*, unlike the program of a digital computer. See Chapter 3, 'How Neural Arrays Adapt and Learn'.

neural migration (NUR-el my-GRAY-shun; from Greek *neuron* = nerve): Movement of nerve cells from their place of origin toward their final location in the growing brain. See Chapter 15, 'Prenatal Development: From Blastocyst to Baby'.

neural net model (NUR-el NET MO-del; from Greek *neuron* = nerve): Also known as **artificial neural nets (ANNs)**, neural models are simulated, simplified models of selected brain functions. Most are relatively small in scale and do not represent the great complexity of the brain. However, they are important for a better understanding of how neural computation might work. See Chapter 3.

neural tube (NOOR-el TOOB): In developing vertebrate embryos, the cylindrical structure that will turn into the **central nervous system**. See Chapter 15, 'Prenatal Development: From Blastocyst to Baby'.

neuroblast (NUR-o-blast; from Greek *neuron* = nerve; Greek *blastos* = bud, shoot): In early embryos, a dividing cell that will differentiate into **neurons** or **glial cells**. See Chapter 15, 'Prenatal Development: From Blastocyst to Baby'.

neurogenesis (NOOR-oh-JEN-uh-sis; Greek *neuron* = nerve cells; *genesis* = beginning): The origin and differentiation of neurons from progenitor cells. See Chapter 15, 'Prenatal Development: From Blastocyst to Baby'.

neuromodulator (NOOR-o-MOD-u-lay-ter; from Greek *neuron* = nerve; *modulate* is used in the sense of 'influence' or 'regulate'): Certain neurochemicals have very widespread effects in large regions of the brain. These are called **neuromodulators**, whereas **neurotransmitters** are molecules with very local effects in specific synapses. See Chapters 1 and 16.

neuron (NOOR-on or NYOO-ron; from Greek *neuron* = nerve): Nerve cells that transmit information by electrochemical signaling. They are the core components of the human brain, spinal cord, and peripheral nerves. Many different types of neurons exist, from sensory receptors and motor units and neuroendocrine cells to pyramidal neurons, which have long-distance axons, interneurons, which form bushy local connections, and a wide variety of specialized cells. See Chapter 3.

neuron doctrine (NOOR-on or NYOO-ron DOK-trin; from Greek *neuron* = nerve; *doctor* = teacher): A theory credited to the Spanish histologist **Santiago Ramón y Cajal**, stating

that 'the nervous system consists of numerous nerve units (**neurons**), anatomically and genetically independent'. This has been one of the basic assumptions of brain science for the past century. However, the discovery of large numbers of electrical synapses (gap junctions) may challenge some aspects of the neuron doctrine. See Chapter 1, 'Some History, and Ongoing Debates'.

neuropeptide (NOOR-o-PEP-tide; from Greek *neuron* = nerve; Latin *peptidia* = small digestibles): A peptide is a short amino acid chain. Neuropeptides act as local neurotransmitters or neurohormones, influencing appetite regulation, growth hormone, and pain perception. See Chapters 1 and 3.

neurotoxin (NOOR-oh-tok-sin; Greek, *neuron* = nerve cell; Latin, *toxicum* = poison): A chemical that degrades neural functioning, often by blocking normal neural signaling. See Chapter 16.

neurotransmission (NOOT-oh-trans-MISH-en): Electrochemical signaling between nerve cells. See Chapters 3 and 16.

neurotransmitter (NOOR-o-TRANS-mit-er; from Greek *neuron* = nerve; Latin *trans* = moving through): Chemicals that act to relay a signal from one neuron to the next across a synaptic cleft. Some neurotransmitters are packaged into **vesicles** that cluster beneath the membrane on the presynaptic side of a **synapse** and are released into the **synaptic cleft**, where they bind to receptors located on the postsynaptic membrane. Release of neurotransmitters often is driven by **action potentials** in the presynaptic axon. There is a low level of baseline release even in the absence of an action potential. See Chapters 1, 3, and 16.

neurulation (nur-uh-LAY-shun or nyur-uh-LAY-shun; from Greek *neuron* = nerve): The early development of the **central nervous system** in the vertebrate fetus. See Chapter 15, 'Prenatal Development: From Blastocyst to Baby'.

norepinephrine (nor-epih-NEF-rin; Greek, *epi* = on top of; *nephros* = kidney; *-in* = protein): Also called noradrenaline. A brain chemical with dual roles as a circulatory hormone and a chemical neurotransmitter. See **adrenaline**, **noradrenaline**. See Chapter 16.

object permanence (OB-jekt PER-ma-nens): The knowledge that perceptual objects continue to exist even when they cannot be seen or touched. Object permanence begins in infants around 7 months. See Chapter 15, 'Developing Mind and Brain'.

occipital lobe (ox-SIP-it-al lowb; from Latin *occiput* = a back bone of the skull): The occipital lobes, which contain the earliest visual region of the cortex, are the smallest of four lobes in the human **cerebral cortex**. See Chapters 1 and 5.

ontogeny (on-TODG-en-ee; from Greek *ontos* = being; Greek *geneia* = origin): The development or course of development, especially of an individual organism. See Chapter 12, 'Phylogeny and Ontogeny'.

orbitofrontal cortex (or-bit-oh-FRON-tel COR-teks; from Latin *orbis* = circle, orb, orbit, world, referring to the part of the brain immediately above the sockets or *orbits* of the two eyes; Greek *cortex* = bark): A specific frontal lobe syndrome where patients may show euphoria, hyperactivity, and loss of impulse control. See Chapter 12, 'Frontal Lobe Dysfunction'.

orbitofrontal syndrome (or-bit-oh-FRON-tel SIN-drome; from Latin *orbis* = circle, orb, orbit, world, referring to the **orbitofrontal cortex** immediately above the sockets or *orbits* of the two eyes): A specific frontal lobe syndrome where patients may show euphoria, hyperactivity, and loss of impulse control. See Chapter 12, 'Frontal Lobe Dysfunction'.

output functions (OWT-put FUNK-shuns): Brain processes controlled by the **frontal lobes** that include the **central executive**, action planning, and motor output. Chapter 2, 'Classical Working Memory'.

paleocortex (PAY-lee-o-COR-teks; from Greek *paleo* = old, ancient; Greek *cortex* = bark): An evolutionary ancient region of the **cerebral cortex** including the **medial temporal lobes**, olfactory cortex, and **hippocampus**. See Chapter 2, 'Classical Working Memory'.

Panksepp, Jaak (b. 1943): A founder of **affective neuroscience**, the study of the brain basis of emotion. Panksepp is known for his research on laughter in other mammals (in response to tickling) as well as high-frequency separation distress cries, such as occurs when rat mothers and their pups are separated. See Chapter 13, 'Panksepp's Emotional Brain Systems'.

parahippocampal place area (PAIR-a-HIP-o-KAMP-el; from Greek *para* = before; see **hippocampus (PPA)**): A region near the hippocampus that responds more strongly to landscapes and visual scenes than to isolated objects like houses or faces. See Chapter 6, 'Functional Organization of the Visual System'.

paralinguistic (PAIR-uh-lin-GWIS-tik; from Greek from *para* = near; Latin *lingua* = language): The nonverbal aspects of linguistic communication, such as voice intonation, gesture, social distance, and eye contact. See Chapter 11, 'Meaningful Statements'.

pathology (path-OL-uh-gee; from Greek *pathologia* = study of the emotions): Something abnormal. The study of the essential nature of diseases and especially of the structural and functional changes produced by them. See Chapter 12, 'Frontal Lobe Dysfunction'.

periaqueductal gray matter (PAG; peh-ree-ah-kwa-DUK-tel GRAY MA-ter; from Greek *peri* = near; Latin *aqueductus* = water channel): The gray matter that surrounds the midbrain and **brainstem** tube (aqueduct) that carries cerebrospinal fluid between the ventricles and the spinal cord. See Chapter 13, 'The Fear System'.

parietal lobe (puh-REYE-uh-tl lowb; from Latin *parietalis* = relating to walls): A large cortical region located above the

occipital lobe and behind the **frontal lobe**. The parietal lobe integrates sensory information from different modalities, and contains constantly updated maps of the position of the body and nearby objects. See Chapters 1 and 5.

parietal neglect (puh-REYE-uh-tl neh-GLEKT; from Latin *parietalis* = relating to walls): A condition in which damage to the right parietal lobe causes the left side of egocentric space to become unconscious. See Chapter 13, 'The Fear System'.

Pavlov, Ivan Petrovich (1849–1936): Russian physiologist. He was awarded the Nobel Prize in Physiology or Medicine in 1904 for research pertaining to the digestive system. He is best known for describing 'classical conditioning', in which an arbitrary stimulus like the sound of a bell came to signal the coming of a biological stimulus like food, thereby eliciting salivation. Pavlov's proposal that conditional reflexes are the basic unit of all human **learning** is no longer generally believed. However, Pavlovian conditioning is widely used in research and is relevant to clinical issues such as food preferences and aversions, and perhaps anxiety disorders. See Chapter 1, 'Some History, and Ongoing Debates'.

Penfield, Wilder (1891–1976): A neurosurgeon and researcher in Montreal who performed pioneering work in epileptic surgery. Before operating, he performed exploratory brain stimulation in awake patients (who were free of pain using only local anesthetic in the surgical opening). Thus patients could report their experiences upon electrical brain stimulation. Penfield and coworkers were able to determine functions of the human brain that were previously only approachable via postmortem studies of brain damaged patients. See Chapter 4, 'A Range of Useful Tools'.

perceptual filling in (per-SEP-choo-el FIL-ing in): A general feature of sensory perception in which the brain fills in missing parts of a visual object or scene, often far beyond the direct sensory input. See Chapter 6, 'Linking Brain Activity and Visual Experience'.

perceptual memory (per-SEP-choo-el MEM-ree, MEM-eh-ree; from Latin *memor* = mindful): Long-lasting changes in one's ability to perceive the world, e.g., the ability to perceive the sounds of speech, and to recognize visual objects under changes in orientation and lighting. See Chapter 2, 'Classical Working Memory'.

peripheral nervous system (PNS; per-IF-er-el NUHR-vus SIS-tem): The extensive network of neurons outside of the brain and spinal. The PNS includes sensorimotor neurons below the neck, and autonomic neurons that innervate the smooth musculature of the digestive tract, heart, and circulatory system. See Chapter 5, 'Introduction'.

perseveration (per-sev-er-AY-shun; from Latin *perseverare* = persist): A symptom involving the inappropriate and uncontrollable repetition of a specific word, phrase, or gesture. See Chapter 10, 'Explicit Problem-Solving'.

phenotype (FEE-no-tipe; Greek *phainein* = to show; *typos* = type): Any physiological trait of an organism that expresses the DNA blueprint, or genotype. See Chapter 16.

phoneme (FO-neem; from Greek *phōnē* = sound): In human languages, the smallest lexically distinctive category of sound, such as consonants and vowels. See Chapter 7, 'Speech Perception'.

phonemic deficit (fo-NEEM-ic; from Greek *phōnē* = sound): A form of **aphasia** in which speech sounds cannot be identified in terms of **phonemic** categories. See Chapter 7, 'Speech Perception'.

phosphene (FOS-feen; from Greek *phos* = light; Greek *phainein* = to show): Light spots in the visual field that are induced by direct mechanical, electrical, or other stimulation of the retina or visual cortex. Phosphenes have also been reported by meditators, during sensory isolation, and under the influence of drugs, such as hallucinogens. See Chapter 6, 'Manipulation of Visual Awareness'.

phylogeny (feye-LODG-en-ee; from Greek *phylon* = race; Greek *geneia* = origin): The evolutionary history of a kind of organism or a genetically related group of organisms, as distinguished from the development of the individual organism. See Chapter 12, 'Phylogeny and Ontogeny'.

pituitary gland (pi-TOO-uh-tehree gland; from Latin *pituita* = phlegm, from the former belief that the pituitary secreted phlegm): The 'master gland' of the body, also called the hypophysis. An endocrine gland about the size of a pea that appears to hang from the **hypothalamus** at the base of the brain. The pituitary works with the hypothalamus to regulate developmental stages and homeostasis. See Chapter 5, 'Growing a Brain from the Bottom Up'.

planum temporale (PLAH-num tem-por-AHL-eh; from Latin *planum* = a flat surface; Latin *temporalis* = of the temple): A part of the **auditory cortex** involved in sound analysis and particularly speech perception. See Chapter 7, 'Functional Mapping of Auditory Processing'.

plasticity (plas-TI-SI-tee; from Greek *plastikos*, from *plassein* = to mold, form): The ability of the brain to adapt and reorganize to new environmental inputs or demands, or following brain damage. See Chapter 7, 'Music Perception'.

pons (PONZ; Latin, *pons* = bridge): A prominent anterior bulge in the **brainstem**. The pons relays sensory information between the **cerebellum** and the forebrain and spinal cord, helps to control sleep and wakefulness, and regulates respiration among other functions. It also generates **REM sleep** signals that are interpreted by the cortex as visually vivid, narrative dreams. See Chapter 5, 'Growing a Brain from the Bottom Up'.

positron emission tomography (PET) (POH-zi-tron ee-MISH-en tom-OG-reh-fee; Latin *emittere* = to send out; Greek *tomos* = section; Greek *graphein* = writing): Positrons are positively charged subnuclear particles, typically produced by a particle accelerator. PET is a low-level radioactive

imaging technique that allows the computational extraction of brain or body slice maps, from which a three-dimensional image can be constructed. See Chapter 4.

postcentral gyrus (post-SEN-tral JEYE-res; from Latin *post* = behind; Latin *gyrus* = ridge): A protruding fold in the **parietal lobe** of the human brain immediately behind the **central sulcus**. It includes the **primary somatosensory cortex**, the first cortical map of the body senses, also called the **sensory homunculus**, which represents the opposite or **contralateral** side of the body.

posterior (pos-TEER-ee-er; from Latin *post* = after): Behind. In brain anatomy, **posterior** is synonymous with **caudal**.

prefrontal cortex (pree-FRON-tal KOR-teks; from Latin *prae* = in front of; *frons* = the forehead; Greek *cort* = bark): The large, forward portion of the **frontal lobes**, not including the motor cortex. Prefrontal cortex includes **executive** functions and Broca's area, and is sometimes called 'the organ of civilization'. See Chapter 2, 'Classical Working Memory'.

primary motor cortex (PRIE-mar-ee MO-ter KOR-teks; from Latin *primus* = first; Greek *cort* = bark): The brain region that directly controls skeletal (voluntary) muscles. It corresponds to the **motor homunculus**, and works in close association with other sensory body and motor maps, such as the premotor cortex.

primary somatosensory cortex (PRIE-mar-ee so-MAT-o-SENS-ery KOR-tex; from Latin *primus* = first, most important; *soma* = body; *sensus* = sense; Greek *cort* = bark): The sensory homunculus (body map), located on the **postcentral gyrus** of the cortex, it is the first cortical area for the body senses.

primary visual cortex (PRIE-mar-ee VIZH-oo-el KOR-teks; from Latin *primus* = first, most important; Latin *visus* = sight; Greek *cort* = bark) (also called V1): The first cortical map of the visual system, located in the **occipital lobe**. See Chapter 6, 'Functional Organization of the Visual System'.

problem space (PROB-lem SPAYS): A graph of the decision points in problem solving, often in the form of a tree structure. See Chapter 10, 'Explicit Problem Solving'.

procedural memory (pruh-SEE-der-el MEM-ree, MEM-eh-ree; from Latin *procedere* = a way of doing things; Latin *memor* = mindful): A form of **implicit memory** equivalent to skill memory, or knowing how to do a task. It appears to be largely unconscious. This type of **memory** is often very durable. See Chapter 2, 'Classical Working Memory'.

process specificity (PRAH-ses spes-i-FIS-ih-tee): The claim that a cognitive process may utilize a variety of different brain regions. See Chapter 12, 'A Closer Look at Frontal Lobe Function'.

proprioception (PRO-pree-o-SEP-shun; from Latin *proprius* = one's own; Latin *perceptio* = perceiving): Senses relating to the

self, including one's location in space, based both on internal and external sensory input.

proteome (PRO-tee-OME; by analogy to genome): The entire set of proteins expressed by a genome.

pure word deafness: The inability to comprehend spoken word meanings, while still being able to hear sounds, to speak, read, and write. Associated with bilateral damage to the **posterior superior** (rear upper) **temporal lobes** or their subcortical connections. See Chapter 7, 'Speech Perception'.

radial unit model (RAY-dee-el YOO-nit MAH-del): A model of **neural migration** proposed by neuroscientist **Pasko Rakic** that asserts that in the developing cerebral cortex, the cells are created at the base of each cortical column and each new cell migrates past its predecessors. See Chapter 15, 'Prenatal Development: From Blastocyst to Baby'.

Rakic, Pasko (b. 1933) (rah-KEECH): A neuroanatomist who showed that neural migration occurs radially as well as rostrally, like the outflowing spokes of a forward-moving wheel. See Chapter 15, 'Prenatal Development: From Blastocyst to Baby'.

Ramón y Cajal, Santiago (1852–1934): Spanish pioneer in microscopic studies of the brain. He often is considered to be the founder of brain science. Many of his detailed drawings of brain tissue slices are still presented today. See Chapter 1, 'Some History, and Ongoing Debates'.

receptive field (ree-SEP-tiv FEELD; from Latin *recipere* = to take): The receptive field of a nerve cell in the visual system, for example, is the region of the visual field that can activate or inhibit the firing of the cell. The receptive field of a retinal receptor is therefore different from the receptive field of a higher level cell tuned to detect motion or visual object identity. Analogous receptive fields have been found for visual attention in the parietal lobe. Receptive fields are found in other sensory systems as well, such as the auditory and somatosensory systems. See Chapter 3, and Chapter 6 for more discussion on receptive fields in the visual system.

re-entrant connectivity (ree-EN-trentcon-ec-TIV-e-tee): Most brain connections are bidirectional, in that activity at point A triggers activity at point B and vice versa. See Chapter 3, 'Working Assumptions'.

re-entry (ree-entry): In Neural Darwinism, the resonant looping between two neurons or arrays of neurons, so that neuron A activates neuron B and vice versa. Re-entry can also take place between neuronal populations. It is believed to be the primary signaling mechanism among brain regions, and therefore closely related to brain rhythms.

reflex circuit (REE-fleks SIR-kut): Also called a reflex arc, this is the relatively simple pathway that mediates a reflex action. The most common example is the knee-jerk (or patellar tendon) spinal reflex, which occurs even when the spinal cord is isolated from the brain. However, spinal reflexes can be quite fast, complex, and coordinated, and may interact with the brainstem and the vestibular (balance) system, as in

the case of a cat reorienting its body during a fall. Normally reflexes work in close coordination with voluntary control via the frontal lobes, cerebellum, and basal ganglia. Cranial reflexes like the pupillary reflex are under the joint control of autonomic, visual, and emotional regions of the brain. See Chapter 3, 'Working Assumptions'.

region of interest (ROI; REE-gen of IN-trest): A region of the brain selected to be tested in a brain imaging study, in order to make statistically valid predictions about expected activity in that region. See Chapter 4.

replication (rep-lih-KAY-shun): 1. Copying of a genome in inheritance. 2. Redoing an experiment by using the exact same methods in order to verify the findings with a new subject group.

reticular formation (reh-TIC-u-ler for-MAY-shun; from Latin *reticulum* = network): A part of the brainstem that is involved in the sleep-waking cycle and many other functions. It receives collateral input from all sensory and motor systems, as well as from higher-level brain structures. It is evolutionarily one of the oldest parts of the brain. See Chapter 5, 'From 'Where' to 'What': The Functional Roles of Brain Regions'.

reticulofrontal disconnection syndrome (reh-tic-yoo-lo-FRON-tel dis-kon-EK-shun SIN-drome; from Latin *reticulum* = network; *frons* = the forehead): A deficit of executive functioning thought to be caused by damage to the pathways connecting the **frontal lobes** to the 'network-like' (reticular) structures of the **brainstem** and mesencephalon. See Chapter 12, 'Frontal Lobe Dysfunction'.

retina (REH-tin-a): The array of light receptors lining the inner surface of the eye. Light striking retinal receptors (rods or cones) trigger a chemical reaction that evokes a change in electrical potential across the cell membrane. This may trigger activity in retinal ganglion cells that project their axons to make up the optic nerve, which terminates in the visual relay nucleus of the thalamus. See Chapter 6, 'Functional Organization of the Visual System'.

retrograde amnesia (RET-ro-grayd am-NEE-zhuh; from from Latin *retrogradus* = going back; Greek *a-mnesia* = without memory): A form of memory loss extending before the time of brain injury. Contrasted with **anterograde amnesia**. See Chapter 9, 'Amnesia'.

retrovirus (RET-roh-VEYE-rus; Latin, *retro* = backward; *virus* = venom). A virus that acts in reverse from the conventional flow of DNA-RNA-protein. Retroviruses are RNA parasites that can be integrated into the DNA of host cells. The HIV virus was the first retrovirus to be studied in great detail. Retroviruses are utilized to insert or delete specific genes into cellular DNA.

reversal conditioning (ree-VER-sel kon-DISH-un-ing): A technique using **classical conditioning** in which an animal is first conditioned to fear one stimulus and not to fear another one. In the next phase, these conditions are switched, and the animal must adapt to a rapid reversal of the cues for fearful events. See Chapter 13, 'The Fear System'.

sagittal (SAJ-i-tal; from Latin *sagitta* = arrow): Any section of the brain that runs parallel to the **medial** or **midline** cut. See Chapter 1, 'Some Starting Points'.

scotoma (skeh-TO-ma): A damaged or missing part of the retina, or of a higher-level neuronal map of the visual field. Scotomas often are filled in with information from regions adjacent to the missing neurons. See Chapter 6, 'Manipulation of Visual Awareness'.

second-person perspective (SEH-kond PER-son per-SPEK-tiv): A person-to-person point of view, considered as a meeting between two subjective perspectives, self and other. See Chapter 14, 'Overview'.

selectionism (suh-LEK-shun-izm): A brain theory based on Neural Darwinism. In biological evolution species adapt by reproduction, mutations leading to diverse forms, and selection among the resulting repertoire of slightly different organisms. Neural Darwinism suggests a similar selectionist process in the growth of neurons and their synaptic connections. See Chapter 3, 'How Neural Arrays Adapt and Learn'.

selective attention (suh-LEC-tiv a-TEN-shun): The ability to pay attention to one aspect of the environment while ignoring competing stimuli. This may occur voluntarily, as in choosing to read an interesting book while sitting on a noisy bus, or when one sensory experience is biologically or personally significant. See Chapters 2 and 8.

semantic deficit (seh-MAN-tic DEF-ih-sit): A form of **aphasia** involving a loss of a particular domain of meaning, such as animal names. See Chapter 7, 'Speech Perception'.

semantic memory (seh-MAN-tic MEM-ree or MEM-er-ee): A type of **declarative memory** that involves meanings, factual beliefs, categories, and other general knowledge going beyond specific experiences. See Chapter 2, 'Classical Working Memory'.

semantics (seh-MAN-tiks): The study of meaning in language. See Chapter 11, 'Introduction'.

sensory system (SEN-suh-ree SIS-tem): Part of the nervous system responsible for processing sensory information. A sensory system consists of sensory receptors, neural pathways, and mostly posterior cortex involved in sensory perception. The classical senses have many subsenses, like pain and even tickle sensations, light receptors in the eye that trigger melatonin as a sleep hormone, the balance sense, and the like. Not all sensory systems yield conscious experiences; blood pressure, for example, which is sensed by hypothalamic neurons, is rarely conscious. The classical senses begin with receptor surfaces containing many millions of receptors, such as the retina and the basilar membrane. See Chapter 2, 'Introduction'.

sequential grouping (seh-KWEN-shul GROOP-ing): One way in which the human auditory system organizes sound into perceptually meaningful elements. If sound properties are repeated in the same sequence, they may be grouped

together. See Chapter 7, 'Functional Mapping of Auditory Processing'.

serotonin (seh-roh-TOE-nin; Latin, *serum* = blood, *tonus* = tension): A neurotransmitter that was originally discovered as a blood-pressure-regulating hormone. Serotonin has multiple functions in the brain and spinal cord, and serotonin dysfunction is believed to be responsible for some brain disorders.

shadowing (SHA-doe-ing): An experimental technique to study selective attention in which subjects repeat speech immediately after hearing it. With practice, subjects can learn to shadow speech with a lag time of less than a second. The shadowing task is sufficiently demanding that other streams of speech cannot be understood at the same time. See Chapter 8.

simulation theory (sim-yoo-LAY-shun THEE-eh-ree): The notion that we sometimes mentally simulate or imitate what we believe others to be experiencing, in order to understand them. See Chapter 14, 'Overview'.

simultaneous grouping (SEYE-mul-TAY-nee-us GROOP-ing): If two sounds have common onsets (beginnings) and offsets (endings), they may be grouped together. One way in which the human auditory system organizes sound into meaningful elements. See Chapter 7, 'Functional Mapping of Auditory Processing'.

sound localization (SOUND lo-cal-ih-ZAY-shun): Identifying the location of a sound, often based on **binaural disparities** of timing and loudness between the two ears. See Chapter 7, 'Functional Mapping of Auditory Processing'.

source memory (SORS MEM-ree or MEM-er-ee): **Memory** for the specific time, place, and circumstances when an event was experienced. See Chapter 9, 'Varieties of Memory'.

spectrograph (SPEK-tro-graf; from Latin *spectrum* = appearance; Greek *graphon* = to write): A machine developed during World War II by Bell Telephone Laboratories to analyze sound signals and produce a picture called a spectrogram, showing sound frequencies over time. See Chapter 7, 'Speech Perception'.

spiking code (SPI-king CODE): The rate and pattern of action potentials, which may transmit useful information in the brain. See Chapter 3, 'Arrays and Maps'.

stimulus-driven attention (STIM-u-lus DRI-vn a-TEN-shun): The capture of **attention** by salient stimuli. See Chapter 8.

Stroop test (STROOP test): Named after American psychologist John Ridley Stroop, who first wrote about this phenomenon in English in 1935. When the name of a color, such as *blue*, *green*, or *red*, is printed in a color differing from that expressed by the word's meaning (e.g., the word *red* is printed in blue ink), a subject has more difficulty naming the color of the word and is slower and more prone to errors than when the meaning of the word is congruent with its color.

This phenomenon is known as the Stroop effect. The Stroop effect is useful in activating conflict-related regions of the brain, and generalizes well to related tasks, like the ‘emotional Stroop’. See Chapter 8.

superior (soo-PEER-ee-er): Above. In the human brain, it is synonymous with **dorsal**.

supratemporal plane (SOO-pra-tem-per-el PLANE): A flat region of **cortex** in the Sylvian fissure, where primary and secondary auditory cortex and parts of **Wernicke’s area** are located. See Chapter 5, ‘From ‘Where’ to ‘What’: the Functional Roles of Brain Regions’.

Sylvian fissure (SIL-vee-en FISH-er): Also called the **lateral sulcus** or lateral fissure. This prominent ‘valley’ of the cortex divides the **frontal lobe** and parietal lobe above from the **temporal lobe** below. See Chapter 5.

synapse (SIN-aps): Synapses are tiny gaps between neurons that communicate by way of chemical neurotransmitters. Synapses are a basic computational element of the brain, a kind of traffic control point for the flow of information. The brain has tens of billions of neurons, but it has many trillions of synapses.

synaptic cleft (sin-AP-tic CLEFT): The space between two **neurons** that can communicate with each other via neurotransmitters. See Chapter 3.

synaptic pruning (sin-AP-tik PROO-ning): The selective loss of **synapses** in the brain when some potential connections are not utilized. See **Hebbian learning**, **neural Darwinism**. See Chapter 15, ‘The Developing Brain: A Lifetime of Change’.

synaptogenesis (sin-AP-toe-GEN-eh-sis): The birth of **synapses** in the brain. See Chapter 15, ‘The Developing Brain: A Lifetime of Change’.

syntactic analysis (sin-TAK-tik uh-NAL-ih-sus): The identification of grammatical structures from words, phonemes, and morphemes. See Chapter 11, ‘Introduction’.

syntax (sin-TAKS): The rules and regularities of sentences in natural languages. See Chapter 11, ‘Introduction’, and ‘Syntax, Nesting, and Sequencing’.

Talairach coordinates (tal-AY-rahk co-ORE-din-etz): A precise three-dimensional coordinate system for the human brain that can localize any point in the brain with millimeter precision. See Chapter 5, ‘Introduction’.

temporal envelope (TEM-por-al EN-ve-lope; from Latin *tempor* = time): The rising and falling intensity of speech signals over time. See Chapter 7, ‘Speech Perception’.

temporal lobe (TEM-por-al lobe): The temporal lobes are parts of the cerebral **cortex** that are involved in visual perception, hearing and speech perception, and **memory encoding** and **recall**. They emerge from the sides of the cortex, beneath the **lateral sulcus**. In profile, if the human brain resembles a boxing glove, the temporal lobes would be the thumb of each side. The temporal lobe envelops the **hippocampus** and

amygdala and is therefore involved in emotion and memory formation as well. The **medial temporal lobe** (most easily seen from the bottom perspective of the brain) is ancient paleocortex, including olfactory cortex. See Chapters 1 and 5.

teratogen (ter-AT-e-jen): A chemical or other factor that causes developmental malformations. See Chapter 15, ‘Prenatal Development: From Blastocyst to Baby’.

terminal (TER-mi-nul): The distal end of an **axon**. See Chapter 3, ‘Introduction’.

thalamo-cortical system (THAL-a-mo COR-ti-keel SIS-tem; from Greek *thalamos* = chamber; Greek *cort* = bark): A central hub in the brain involving the **cortex** and **thalamus**, allowing signal traffic to flow flexibly back and forth in both directions. See Chapter 5, ‘Introduction’.

thalamus (THAL-a-mus; from Greek *thalamos* = room, chamber): A pair of symmetric egg-shaped structures in the brain that provide the main cortical input hub and cortico-cortical traffic hub. See Chapter 1, ‘Some History, and Ongoing Debates’.

theory of mind (THEE-eh-ree or THIR-ee of MIND): The ability to attribute mental states – beliefs, desires, intentions – to others. See Chapter 14, ‘Overview’.

theory (THEE-eh-ree or THIR-ee): The notion that children develop implicit theories of other people over time, much as scientists produce theories over many years of testing and development. See Chapter 14, ‘Overview’.

theta waves (THAY-ta WAVZ; eighth letter of Greek alphabet): Theta waves are regular electromagnetic waveforms with a typical frequency of 3.5 to 7.5 Hz. One role of theta is to coordinate hippocampal memory encoding with the neocortical sites of synaptic memory storage. Theta is also involved with the reverse process of episodic retrieval. Theta rhythms are thought to involve many **neurons** firing in synchrony, driven by cholinergic neuromodulation.

third-person perspective (THIRD PER-son per-SPEK-tiv): A public viewpoint on evidence. Public evidence for some hypothesis is typically required in science. See Chapter 14, ‘Overview’.

transcranial magnetic stimulation (TMS; trans-CRAY-nee-el mag-NET-ic stim-yoo-LAY-shun): A relatively noninvasive method using powerful electromagnets outside of the head to stimulate or inhibit cortical neurons. TMS shows good temporal and spatial resolution. See Chapter 4, ‘A Range of Useful Tools’.

transcription (tran-SKRIP-shun; Latin *trans* = across, *scribere* = to write): The copying of DNA into messenger RNA. See Chapter 16.

translation (trans-LAY-shun): The conversion of messenger RNA into active proteins.

triune brain (TRY-oon BRAYN; Latin, *tri* = three): A broad model proposed by Paul MacLean to characterize the human brain in terms of three major evolutionary stages of

development, including the reptilian complex, limbic system (mammalian), and neocortex (primates and other large-brained mammals, with a large frontal lobe expansion in humans). See Chapter 13.

unconscious perception (un-CON-shus per-SEP-shun): Sensory stimulus processing without awareness of the stimulus. See Chapter 6, 'Manipulation of Visual Awareness'.

utilization behavior (yoo-til-ih-ZAY-shun be-HAYV-yor): Also called *field-dependent behavior*. A frontal lobe disorder in which victims may imitate the actions of an examining physician or find it irresistible to use tools placed in front of them. See Chapter 12, 'Frontal Lobe Dysfunction'.

ventral (VEN-trel; from Latin *venter* = the belly): The lower part of a brain structure, inferior.

ventricles (VEN-trik-lz): Four small cavities in the brain containing circulating cerebrospinal fluid. The ventricular walls have been found to be sites for neural stem cells. See Chapter 5, 'Growing a Brain from the Bottom Up'.

ventromedial prefrontal cortex (ven-tro-MEE-dee-el pree-FRON-tal KOR-teks; Latin *venter* = the belly; *medialis* = in the middle): The bottom midline structures of the frontal lobe, especially in humans and other primates. This region, extending backward from the top of the nose, is involved in emotions, infant-mother bonding, fear, and risk in decision making. See Chapter 12.

verbal dyspraxia (VER-bl dis-PRAK-see-uh; Greek, *dys* = impaired; *praxis*, action): A condition in which speaking is impaired. See Chapter 16.

verbal rehearsal (VER-bel ree-HER-sel): Mental repetition of words to be remembered, using the 'inner speech' component of *working memory*. Inner speech involves a spontaneous commentary on current concerns, goals, and emotions. See Chapter 2, 'Classical Working Memory'.

Vesalius, Andreas (1514–1564): Belgian physician who produced the first accurate atlas of human anatomy in 1543, called **On the Fabric of the Human Body**. Vesalius' book was a major milestone in the Renaissance rediscovery of science and medicine. See Chapter 1, 'Some History, and Ongoing Debates'.

vesicle (VES-i-cl; from Latin *vesicula* = small bladder): The small bubbles filled with neurotransmitter molecules that travel through the axon to the synaptic terminals, where they fuse with the synaptic membrane to release neurotransmitters into the cleft when an action potential occurs. Neurotransmitters then diffuse across the synapse to trigger depolarization of the postsynaptic membrane, ultimately leading to another axonal spike. Vesicles are essential for the propagation of signals between neurons and are constantly recreated by the cell. See Chapters 3 and 16.

visual agnosia (VI-zhoo-el ag-NO-zhe; from Greek *agnōsia* = lacking knowledge): A condition in which a person has difficulty recognizing objects because of damage to

object-recognition regions of the cortex, such as the inferior temporal lobe. See Chapter 6, 'Brain Areas Necessary for Visual Awareness: Lesion Studies'.

visual backward masking (VI-zhoo-el BAK-werd MAS-king): A conscious visual image can be 'erased' by a subsequent visual event, such as a cross-hatch display, even though the conscious event is not physically blocked from reaching the retina. See Chapter 8.

visual phantoms (VIZH-oo-el FAN-tems; from Anglo-French *fantasme* = phantasm): A form of **perceptual filling in** in which visual forms seem to float in front of the surrounding shapes and colors that create the illusion. See Chapter 6, 'Linking Brain Activity and Visual Experience'.

visuospatial sketchpad (vizh-oo-oh-SPAY-shul SKECH-pad): The ability to hold visual and spatial information momentarily in **working memory**. See Chapter 2, 'Classical Working Memory'.

vocoder (VO-CO-der; from *voice* + *coder*): A technology developed by Bell Telephone Laboratories to transmit highly filtered speech with minimum loss of intelligibility. The technology forms the basis for cochlear implants. See Chapter 7, 'Speech Perception' and Box 7.1.

volition (vuh-LI-shun): Voluntary control of actions, as contrasted with automatic control, as in the case of highly practiced habits. Many brain disorders involve a loss of voluntary control. See Chapter 12.

Wearing, Clive (b. 1938): A prominent British classical musician who suffered a viral brain infection in his forties that destroyed both hippocampi and some frontal lobe regions. Wearing's case has become well known due to the efforts of his wife, Deborah Wearing, to raise public awareness of such medical conditions. Wearing lives in a single, blindered moment, without the ability to store information for later recall. Despite his **memory** problems, he is still able to play the piano and conduct musical pieces he knew well before the brain injury. See **anterograde amnesia**. See Chapter 2, 'Classical Working Memory'.

Wernicke, Carl (1848–1905): German physician and discoverer of a selective cortical region for speech comprehension. This region is now referred to as **Wernicke's area**, and the associated deficit is known as **Wernicke's** or **receptive aphasia**. Patients with this deficit cannot understand speech, including their own, but produce fluent-sounding (but not usually meaningful) speech. See Chapter 1, 'Some History, and Ongoing Debates'.

Wernicke's aphasia (WER-nik-ees AY-PHAY-zha; from *a* = without; Latin *phasia* = utterance): See **Wernicke, Carl**. See Chapter 1, 'Some History, and Ongoing Debates'; Chapter 7, 'Speech Perception'.

Wernicke's area (WER-nik-ees AIR-ee-a): An area of the upper posterior temporal lobe that is needed for language comprehension. See Chapter 1, 'Some History, and Ongoing Debates'.

white matter: In the brain white matter consists of dense bundles of myelinated **axons**, which connect various **gray matter** areas of the brain to each other. White matter is named for the appearance or massive numbers of **myelinated** nerve axons, which appear to form the visible core of brain structure. See Chapter 1, 'Some History, and Ongoing Debates'.

working memory (WUR-king MEM-ree or MEM-er-ee): A cognitive capacity for storing and manipulating novel information over 10 to 30 seconds. Working memory includes **central executive, working storage, verbal rehearsal**, and the **visuospatial sketchpad**. See Chapter 2, 'Classical Working Memory'.

