Glossary

The purpose of the glossary is to provide a quick reference for the reader who encounters a word in the text that was defined earlier in the book. Accordingly, the words listed below are defined in the (occasionally idiosyncratic) way in which they are used in the text. In some cases, these are more specialized definitions than might appear in a textbook or general-purpose dictionary. For more complete explanations, the reader is referred to the body of the text.

A1: See **Primary Auditory Cortex.**

Ablation: Surgical removal of a (brain) structure; may involve collateral damage to overlying structures.

Acetylcholine (abbreviated **ACh**)**:** A brain chemical that acts as a neurotransmitter in the body, carrying signals to muscles, and a neuromodulator in the brain, mediating the responsiveness of neurons to other inputs.

Ach: See **Acetylcholine.**

ACoA: See **Anterior Communicating Artery.**

ACoA Syndrome: A cluster of symptoms that may follow aneurysm of the anterior communicating artery, including anterograde amnesia, personality changes, and confabulation; the precise symptoms depend on the severity of the aneurysm and on which brain structures are vascularized by the ACoA in that individual.

Acquired Equivalence: A conditioning paradigm in which two superficially dissimilar stimuli (e.g., A and B), having been associated with the same reinforcer, tend also to be associated with each other, so subsequent learning about A tends to generalize to B.

Acquisition: In conditioning, a paradigm that consists of learning a single CS-US association.

Activation Level: The overall probability that a neuron or node will become active or fire on the basis of the sum of its inputs. May also be interpreted as the strength of a node's response to its inputs.

Activation Rule: The rule by which the weighted inputs to a node are converted into node activation levels.

Active: The state in which a node or neuron passes a message on to other nodes or neurons.

AD: See **Alzheimer's Disease.**

Afferent: Of input to a neuron.

Afferent Neuron: A neuron that sends information to another neuron.

Aggregate Error: The difference between the actual US and the aggregate prediction of the US; usually equivalent to (US-CR).

Aggregate Prediction of the US: In the Rescorla-Wagner model, the prediction of US arrival based on all available CSs; used to generate a CR and to compute error for error-correction learning.

Agonist: A drug that facilitates neuronal transmission involving a specific kind of neurotransmitter—for example, by increasing the amount of neurotransmitter produced presynaptically, increasing the effectiveness of postsynaptic receptors, or delaying the removal of excess neurotransmitter from the synapse.

Allocortex: A simple form of cortex with only two cell layers, found in reptiles and birds and in some areas of mammalian cortex.

Alzheimer's Disease (abbreviated **AD**)**:** A progressive, degenerative, neurological illness that results in abnormal neuronal elements called plaques and tangles and that leads to memory loss, cognitive dysfunction, and eventually death.

Amnesia: Severe memory loss; see **Anterograde Amnesia** and **Retrograde Amnesia.**

Amnesic: Of or having to do with amnesia; also refers to an individual with anterograde amnesia.

Amygdala: A subcortical structure that is involved in emotional learning.

Aneurysm: A neurological condition in which the walls of a blood vessel are weakened and may balloon out under pressure and even burst; in this case, structures that depend on that blood vessel to supply oxygen and nutrients are deprived and may die.

Animal Model: Use of a particular animal preparation to capture some aspects of a phenomenon that is observed in humans.

Anoxia: Loss of oxygen supply to the brain, possibly leading to neuronal death.

Antagonist: A drug that impedes neuronal transmission involving a specific kind of neurotransmitter—for example, by decreasing the amount of neurotransmitter produced presynaptically or by blocking postsynaptic receptors.

Anterior: Toward the front.

Anterior Communicating Artery (abbreviated **ACoA**)**:** A blood vessel that supplies oxygen and nutrients to an area that may include the basal forebrain and frontal cortex; a frequent site of aneurysm in humans.

Anterograde Amnesia: A kind of memory dysfunction in which acquisition of new memories is impaired while older memories may survive intact. Certain kinds of nondeclarative memory may also be spared.

Architecture: The physical structure of a neural network, including nodes and how they are connected (but not the strengths of those connections or the pattern of node activations).

Aricept: See **Donepezil.**

Aspiration: Surgical removal of a (brain) structure by suction; may involve collateral damage to overlying structures.

Association: A link between two neurons, nodes, or concepts such that when one is activated, the other may be activated as well.

Association Cortex: Areas of cortex not necessarily limited to processing a single modality; specifically, those areas of cortex that are involved in integrating information, planning, and decision making.

Associational Weights: In a multilayer neural network, the upper layer of weights that connects internal-layer nodes to output-layer nodes, thus specifying how the representation of the current input should be associated with an output.

Associative Learning: Learning about relationships (associations) between stimuli.

Associative LTP: A possible mechanism for associative learning in the brain, whereby simultaneous activity in two neurons leads to a strengthening of the synapse between them.

Associative Weights: The efficacy of one node to cause activation in another node. Often defined as a number that may be modified through learning: If the number is positive, then activity in the first node tends to increase activity in the receiving node; if it is negative, then activity in the first node tends to depress activity in the receiving node.

Asymptote: The maximum possible value of a variable; appears as a leveling-off point in a graph of that variable.

Atrophy: Abnormal shrinkage.

Autoassociative Network (or **Autoassociator**)**:** A class of neural network, characterized by a high level of connectivity between nodes, that can store arbitrary input patterns and recall them later on the basis of partial cues.

Autoencoder Network (or **Autoencoder**)**:** A variant of an autoassociator that includes an internal layer of nodes; outputs may be trained to reconstruct the input pattern according to an error-correction learning rule.

Axon: The output process of a neuron.

Backprojection: Projections from a brain area back to other regions that originally provided input to that area.

Backpropagation: See **Error Backpropagation Learning Algorithm.**

Basal Forebrain: A group of structures lying near the bottom and front of the brain, including medial septum and nucleus basalis.

Best Frequency: The auditory frequency (pitch) that maximally activates a particular pyramidal neuron in primary auditory cortex.

β: See **Learning Rate.**

Bias: A parameter that is sometimes used in neural networks that specifies a node's innate activation level before any other input is received.

Bilateral: Referring to both sides (hemispheres) of the brain, as in bilateral lesion.

Blocking: A conditioning paradigm in which prior learning that one CS A predicts the US blocks or reduces the amount of learning about a second CS B during subsequent AB-US training.

CA: See **Cornu Ammonis.**

CA1: A subfield of the hippocampus.

CA3: A subfield of the hippocampus, noted for its high degree of internal recurrency.

Category Learning: Learning that individual stimuli belong in particular categories, according to some predefined rule.

Cell Synchronization: Firing of various neurons simultaneously or in a distinct rhythm with respect to one another.

Cerebellar: Of the **Cerebellum.**

Cerebellar Model: A model of cerebellum, proposed by R. Thompson, that assumes that the cerebellum is capable of error-correction learning by making use of an error signal provided by the inferior olive.

Cerebellum: A structure at the rear of the brain that is involved in coordination and fine control of movement.

Cerebral Cortex: A thin gray sheet of tissue forming the surface of the brain, where memories are stored. Different regions of cortex are involved in processing different kinds of information.

Cholinergic: Of acetylcholine.

Chunking: A hypothesized mechanism whereby a set of co-occurring stimuli come to be treated as a unary whole or configuration that can accrue associations with the US.

Classical Conditioning: Learning that a previously neutral stimulus (the conditioned stimulus or CS) predicts a response-evoking stimulus (the unconditioned stimulus or US). With repeated CS-US pairing, the subject comes to give an anticipatory response (the conditioned response or CR) to the CS alone.

Climbing Fibers: A pathway from inferior olive to cerebellum that may carry error information to guide error-correction learning in the cerebellum.

Coarse Coding: A form of representation in which each external event (stimulus or stimulus feature) is encoded as a pattern of activity over many nodes or components of a model.

Cognex: See **Tacrine.**

Cognitive Map: A mental model of the environment that an animal can use to navigate, hypothesized by Tolman and later implicit in many models of hippocampal function.

Columnar Architecture: A general organizing principle of cortex in which neurons directly above and below each other in the cortical sheet tend to be interconnected and activated by similar inputs, hence acting as a functional column.

Combinatorial Explosion: The dilemma that results when every possible configuration of inputs is coded explicitly with a single input node (as in the configural cue network): The representation of every configuration of 2 inputs requires 3 nodes, the representation of every configuration of 4 inputs requires 14 nodes, the representation of every configuration of 8 inputs requires 105 nodes, and so on.

Competitive Network: A class of unsupervised network in which nodes are divided into clusters and nodes within a cluster compete to respond to the input. Nodes that win the competition undergo weight changes to make them more likely to win the competition and respond to similar inputs in future.

Component Representation: A form of representation in which each external event (stimulus or stimulus feature) is encoded within one node or component of a model.

Component Stimulus: One of the individual stimuli comprising a compound stimulus.

Compound Stimulus: A complex stimulus consisting of two or more stimuli, always presented together.

Compression: In a network, an increase in the overlap between the representations of two stimuli, which will increase generalization between those stimuli.

Computational Model: A model that is formalized as a computer program and that can generate data to compare against the behavior of the physical system being modeled.

Conditioned Inhibition: A conditioning paradigm in which one CS A predicts the US unless it is paired with a second CS B.

Conditioned Response (abbreviated **CR**)**:** A response that is learned as a result of classical conditioning.

Conditioned Stimulus (abbreviated **CS**)**:** A previously neutral stimulus that comes to evoke a response as a result of classical conditioning.

Conditioning: Learning that one stimulus predicts a second, salient stimulus. Learning is typically measured in terms of a specific response. See **Classical Conditioning** and **Instrumental Conditioning.**

Configural Cue Network: A neural network model of configural learning, proposed by M. Gluck and G. Bower, that assumes that there is one input node representing each CS and each combination of CSs.

Configuration, or Configural Learning: Learning in which a compound stimulus may have different associations or different meaning than the component stimuli that compose it.

Connectionism: The study of the behavior of model neural networks.

Connectionist: Having to do with neural networks or connectionism.

Consolidation Period: Period during which newly formed memories still depend on hippocampus and will be disrupted by hippocampal damage.

Context: The background, usually continuous, stimuli that are present during an experiment (such as the sights, sounds, and texture of the conditioning apparatus).

Context Shift Effect: In conditioning, the finding that a response to a CS trained in one experimental context may be weakened if that CS is presented in a novel context.

Contextual Effects: In conditioning, paradigms that show sensitivity to the context in which training occurs. (See, e.g., **Context Shift Effect.**)

Contextual Sensitivity: The degree to which responses that are learned in one context may be altered or weakened in another context.

Control or Control Group: A subject or group of subjects whose behavior is assumed to be normal, for comparison with a subject or group of experiments whose behavior is manipulated by the experimenter. An *experimental control group* receives the same training but without the critical manipulation. (For example, if an experiment tests the effects of exposure to a CS, the control group might receive equivalent time in the experimental chamber but without presentation of the CS.) A *surgical control group* receives the same surgery but without damage to the critical structure. (For example, if an experiment tests the effects of hippocampal aspiration, the control group might receive the same surgery—anesthesia, incision, etc.—but without removal of the hippocampus.)

Cornea: The transparent coat of the eyeball covering the iris and pupil.

Corneal: Of the cornea.

Cornu Ammonis: An early name for the hippocampus, which survives today in the name of hippocampal subfields, including CA1 and CA3.

Cortex: See **Cerebral Cortex.** (There are cortical areas within the cerebellum as well.)

Cortical: Of the cortex.

Cortical Map: Representation of sensory input (or other information) in a roughly topographic fashion across a cortical surface.

Cortical Remapping: Changing the cortical map.

Cortico-Cerebellar Network: Within Gluck & Myers's cortico-hippocampal model, a network that incorporates some aspects of stimulus representation in cortex and mapping from representation to behavioral response in cerebellum.

Cortico-Hippocampal Model: Neural network model proposed by M. Gluck and C. Myers that assumes that the hippocampal region forms new stimulus representations that compress (make more similar) the representations of redundant stimuli while differentiating (making less similar) the representations of stimuli that predict different future events. These new representations are adopted by the cortex, which is the site of long-term storage, and mapped to behavioral responses.

CR: See **Conditioned Response.**

Credit Assignment: The problem of knowing how to train a network when many different weights may have contributed to the output error.

Criterion: In conditioning, the performance standard that must be mastered before the subject is said to have learned the task (e.g., 80% correct responding over the last ten trials).

Critical Period: The period extending through the first few weeks or months of life during which cortical maps are especially plastic.

CS: See **Conditioned Stimulus.**

CS-CS Learning: Learning associations between two stimuli (CSs) in the absence of (or independently of) explicit reinforcement.

CS-US Learning: Learning an association between a stimulus (CS) and a reinforcer (US); usually, learning that the CS predicts the US and should evoke an anticipatory response (CR).

Cue: An event (particularly a sensory event or stimulus) that is predictive of whether another event will occur.

***D*(A, B):** A formal measure of the overlap in representation between two stimuli A and B, computed as the difference in responding to each stimulus summed across all internal-layer nodes in a network. For example, if there are three internal-layer nodes (N1, N2, and N3), then *D*(A, B) is the difference between N1's responses to A and B *plus* the difference between N2's responses to A and B *plus* the difference between N3's responses to A and B.

Deafferent: Cut off from input; a neuron or brain region is completely or partially deafferented if its normal sources of input are disabled or destroyed.

Declarative Memory: Memory for individual facts or autobiographical events that is easily accessed by verbal recall.

Decrement: Decrease.

Deep Layers: In cortex, the cell layers closest to the interior of the brain.

Delay Conditioning: A conditioning paradigm in which CS onset occurs before US onset and CS and US terminate together.

Delayed Nonmatch to Sample (abbreviated **DNMS):** A recognition task in which a sample object is presented, there is a short delay, and then the sample object and a novel object are presented; the subject must choose the novel object.

Delta Rule: Another name for the **Widrow-Hoff Learning Rule.**

Dendrites: The input processes of a neuron.

Dentate Gyrus: A structure that receives input from entorhinal cortex and produces output that input to hippocampal field CA3.

Desired Output: In a neural network, the value that a node should output to minimize error; often defined with respect to a teaching input.

Differentiation: In a network, a decrease in the overlap between the representations of two stimuli, which will decrease generalization between those stimuli.

Discrimination: In conditioning, a paradigm in which one stimulus (A+) predicts the US but a second stimulus (B−) does not.

Discrimination Reversal: See **Reversal.**

Distributed Representation: A form of representation in which each external event (stimulus or stimulus feature) is encoded as a pattern of activity over many nodes or components of a model.

DNMS: See **Delayed Nonmatch to Sample.**

Donepezil: A drug (brand name: Aricept) that acts as a cholinergic agonist by interfering with the processes that clean extra ACh out of the synapse. Currently marketed as a drug to relieve the symptoms of Alzheimer's disease.

Dysfunction: Impaired or abnormal function.

Easy-Hard Transfer: In conditioning, a paradigm in which learning a difficult discrimination is facilitated by prior learning on a simpler discrimination along the same stimulus continuum. For example, learning to discriminate two similarly bright gray squares might be facilitated by prior training to discriminate a very bright gray versus a very dark gray.

EC Lesion: Lesion that is limited to the entorhinal cortex (and possibly subiculum) but sparing hippocampus and dentate gyrus; note, however, that EC lesion disables the primary pathway by which information enters and exits the hippocampus, so EC lesion may functionally disable the hippocampus as well.

Electroencephalogram (abbreviated **EEG):** A recording of the electrical activity of the brain.

Electrophysiology: Relating to the electrical activity in neurons.

Empirical: Relating to data collected from animal or human experiments (as distinct from data produced by model simulations).

Engram: Physical trace of a memory in the brain—for example, altered neuronal connectivity.

Entorhinal Cortex: A structure within the hippocampal region that provides the primary pathway by which sensory information enters and leaves the hippocampal region.

Entorhinal Model: A model of entorhinal cortex, proposed by C. Myers, M. Gluck, and R. Granger, that assumes that the entorhinal cortex is capable of compressing the representations of co-occurring stimuli.

Episodic Memory: A subdivision of declarative memory that includes memory for specific (often autobiographical) events.

Error: In a neural network, the difference between the desired node output and the actual node output, sometimes calculated across many output nodes.

Error Backpropagation Learning Algorithm: An algorithm for error-correction learning in multilayer networks: The upper layer of weights is trained according to the Widrow-Hoff rule to reduce the error between actual and desired outputs; error is then propagated backward to the lower layer of weights, proportional to their activation (and hence proportional to their contribution to the responses of upper-layer nodes).

Error-Correction Learning: Learning that tries to reduce the difference (error) between the actual network output and a desired or target output.

Errorless Learning: A conditioning paradigm in which subjects are prevented from making any errors during learning; typically, learning begins with a trivially easy version of the problem, and difficulty is slowly increased until the subjects can execute the desired task perfectly.

Etiology: The underlying cause of a brain abnormality (e.g., type of disease or injury).

Event-Specific Amnesia: A form of amnesia in which memory loss is restricted to a particular period of time, such as the duration of a violent crime or other trauma.

Excitatory Neurotransmitter: A neurotransmitter that increases the net activation of a postsynaptic neuron.

Exclusive-Or Task: An engineering version of the negative patterning task, which requires an output of 1.0 if either of two inputs is present but an output of 0.0 if both inputs are present.

Exemplar Model: A network in which one internal-layer node is constructed to represent each configuration of inputs which is actually encountered; proposed as a model of human category learning by researchers such as R. Nosofsky.

Exposure: In conditioning, presentation of one or more CSs without any US.

External Input: In a neural network, input that is provided to the network from outside the system.

External Output: In a neural network, output that is visible outside the network (and may be interpreted as a behavioral response).

Extinction: A conditioning paradigm in which prior CS-US pairing is followed by CS-alone presentation until the CS stops evoking a response.

Extra-Hippocampal: Relating to structures other than the hippocampus.

Extrinsic Input: Input to a brain region originating from outside that brain region.

Eyeblink Conditioning: A conditioning preparation in which a corneal airpuff or shock US evokes a reflexive eyeblink; the CS may be a tone or light, and the CR is an anticipatory eyeblink learned in response to the CS.

Facilitate: Affect positively.

Feature-Negative Discrimination: A conditioning paradigm in which one CS A predicts the US unless it is preceded by a second CS B.

Feature-Positive Discrimination: A conditioning paradigm in which one CS A predicts the US only when it is preceded by a second CS B.

Feedback: In a network, connections from one layer of nodes back to a previous layer of nodes; in a brain, connections from one brain area back to the neurons that provided the input to that brain area.

Feedforward: In a network, connections from one layer of nodes to a higher layer of nodes; in a brain, connections from one brain area to neurons in a brain area that represents a subsequent stage of processing.

Fibers of Passage: Fibers (e.g., axons) that pass through a brain structure or region and may sustain collateral damage if that structure or region is lesioned.

Figure Completion Task: A task in which subjects see progressively less fragmented drawings until they can identify the object; learning is demonstrated if, on subsequent trials, subjects can recognize the object on the basis of a more incomplete version.

Fimbria: The merger zone between hippocampus and fornix.

Fimbrial: Relating to the fimbria.

Fornix: A fiber tract connecting hippocampus with various subcortical structures, including medial septum.

Fugue: A kind of amnesia in which individuals forget their past and identity. Usually caused by psychological, not physical, trauma.

GABA (a Gamma-aminobutyric acid): A inhibitory neurotransmitter in the brain.

GABAergic: Having to do with GABA.

Generalization: The degree to which learning about one stimulus transfers to another stimulus.

Generalization Gradient: A graph showing how a strong response trained to one stimulus generalizes to other stimuli as a function of similarity to the trained stimulus.

Granule Cells: The principal cells of the dentate gyrus (compare with most cortical regions, where the principal cells are pyramidal neurons).

H+EC Lesion: Lesion that includes the hippocampus and entorhinal cortex (and possibly dentate gyrus and subiculum); assumed to be functionally equivalent to a HR lesion.

Hasselmo's Model: A model of hippocampus, proposed by M. Hasselmo and colleagues, that assumes that septohippocampal inputs modulate hippocampal learning.

Hebbian Learning: Learning which proceeds according to Hebb's rule; forms the basis for much learning in self-organizing networks.

Hebb's Rule: The learning principle formalized by D. Hebb: When two nodes or neurons are repeatedly coactive, the weight between them is strengthened.

Hemisphere: One of the two left-right halves of the brain. Many structures, including hippocampus and cortex, have an analogous component in each hemisphere, though the particular functions in each hemisphere may vary slightly.

Herpes Encephalitis: A condition in which the herpes virus enters the brain and attacks neurons there.

HF: See **Hippocampal Formation.**

Hidden Node, Hidden Node Layer: Nodes in a neural network that receive inputs from other nodes and send output to other nodes (i.e., without receiving external inputs or generating external outputs).

Hierarchical Clustering: Grouping inputs according to progressively finer-grained categories (e.g., animal, mammal, dog, terrier).

Hippocampal: Of the hippocampus.

Hippocampal Formation: A subset of hippocampal-region structures, often defined as including the hippocampus and dentate gyrus but not entorhinal cortex.

Hippocampal Region: Used to refer to a collection of brain structures that are implicated in learning and memory, including hippocampus, dentate gyrus, subiculum, entorhinal cortex, and sometimes nearby perirhinal cortex, parahippocampal cortex, and fimbria/fornix.

Hippocampi: Plural of hippocampus.

Hippocampus: A brain structure, lying in each of the medial temporal lobes in humans, that plays a crucial structure in acquisition of new memories.

H Lesion: Lesion limited to the hippocampus (and possibly dentate gyrus and subiculum) but sparing entorhinal cortex.

HL: Hippocampal lesion; specifically, a lesion limited to the hippocampus but sparing nearby structures and fibers of passage.

Homunculus: Pictorial representation of a human form with various components exaggerated or shrunken to reflect the amount of cortical representation that component receives within a given region of cortex.

HR: See **Hippocampal Region.**

HR Lesion: Hippocampal-region lesion; specifically, a lesion that includes the hippocampus and all other structures in the hippocampal region.

Hypoxia: Reduction of oxygen supply to the brain, possibly leading to neuronal death.

Ibotenic Acid: A neurotoxin that, when injected into the brain, destroys neurons near the injection site but spares nearby fibers of passage.

IgG-Saporin: See **Saporin**.

Impair: Affect negatively.

Increment: Increase.

Inferior Olive: A brain structure that receives inputs regarding the conditioned response (CR) and the US and that may provide an error signal (US-CR) to the cerebellum, guiding error-correction learning there.

Information-Processing Theory: A theory that focuses on how different brain structures process information rather than on what specific tasks might be disrupted when these various structures are lesioned or disabled.

Informational Value of a Stimulus: The usefulness of a stimulus in predicting subsequent salient events (such as a US), relative to other available stimuli.

Inhibitory Interneuron: See **Interneuron.**

Inhibitory Neurotransmitter: A neurotransmitter that reduces the net activation of a postsynaptic neuron.

Initialize: In neural network models, the resetting of all connection weights to original values (either 0.0 or small random values) without changing the network architecture, learning rule, or training procedure.

Input Node: A node in a neural network that receives input from outside the network rather than from other nodes in the network.

Input Pattern: A series of external inputs provided to a network for storage or processing.

Instrumental Conditioning: A form of conditioning in which reinforcement is contingent on the response (e.g., if a rat presses a lever, a food reward is available; if the lever is not pressed, nothing happens). Often called *operant conditioning*. Contrast with classical conditioning, in which reinforcement (the US) arrives independent of whether a response (CR) is executed.

Intact: Not having been lesioned, damaged, or otherwise disrupted.

Interference: In a neural network, the phenomenon whereby newly stored patterns can overwrite or merge with previously stored patterns.

Intermediate-Term Memory: Memory that may last minutes to hours but that may be lost thereafter.

Internal Node, Internal-Node Layer: Nodes in a neural network that receive inputs from other nodes and send output to other nodes (i.e., without receiving external inputs nor generating external outputs).

Internal Recurrency: Connections from neurons in one brain region back to other neurons of the same class in the same region, as opposed to connections that travel on to other brain areas.

Interneuron: A type of neuron that typically projects only to other neurons within a local area and has an inhibitory effect on them.

Intrinsic Input: Input to a brain region originating within that brain region (e.g., recurrent collaterals).

Isocortex: A form of cortex with six cell layers, found only in mammals.

Kainic Acid: A neurotoxin that, when injected into the brain, destroys neurons near the injection site but may also destroy nearby fibers of passage; produces a less selective lesion than ibotenic acid.

Kohonen Network: See **Self-Organizing Feature Map.**

Language-Learning Impairment (abbreviated **LLI**): A condition, associated with dyslexia, in which children show specific impairments in language processing without other intellectual deficits.

Latent Inhibition: A conditioning paradigm in which prior unreinforced exposure to one stimulus retards subsequent learning to associate that stimulus with the US.

Latent Learning: Learning that occurs in the absence of any explicit US.

Learned Irrelevance: A conditioning paradigm in which prior exposure to the CS and US, uncorrelated with each other, retards subsequent learning that the CS predicts the US.

Learning Curve: A graph showing how responding changes as a function of training trials.

Learning Rate (sometimes abbreviated β)**:** A parameter in a learning rule that specifies how large weight changes should be.

Learning Rule: A formal procedure for modifying a system to adapt responding based on experience; in neural networks, a rule for modifying weights between nodes.

Least-Mean-Squared Learning Rule (abbreviated **LMS**)**:** Another name for the Widrow-Hoff Learning Rule.

Lesion: As a verb: To damage, destroy, or remove a portion of brain tissue in the course of experiment for the purpose of observing how behavior is modified. As a noun: A localized region of damage to the brain.

LLI: See **Language-Learning Impairment**.

LMS: See **Least-Mean-Squared Learning Rule.**

Local Representation: A form of representation in which each external event (stimulus or stimulus feature) is encoded within one node or component of a model.

Long-Term Memory: Memory that may last weeks or years.

Long-Term Potentiation (abbreviated **LTP**)**:** A neuronal mechanism by which the synapse between two neurons may be strengthened depending on how the neurons' activity is correlated; a candidate mechanism for learning in the brain.

LTP: See **Long-Term Potentiation.**

M1: See **Primary Motor Cortex.**

Magnetic Resonance Imaging (abbreviated **MRI**)**:** A technique for obtaining a detailed picture of the brain by recording molecular fluctuations in a magnetic field.

Medial Septum: A structure within the basal forebrain that projects acetylcholine and GABA to hippocampus.

Medial Temporal Lobe: The part of the human brain lying on the inside of the temporal lobe; corresponds roughly to the hippocampal region in animals.

Mere Exposure Effect: The finding that learning can occur following exposure to the CS in the absence of any explicit US.

Metrifonate: A drug that acts as a cholinergic agonist by interfering with the processes that clean extra ACh out of the synapse and thus increasing the opportunity for ACh to activate the postsynaptic neuron.

Microdialysis: A technique for measuring fluctuations in levels of neurotransmitters or other chemicals within a limited region of brain.

Millisecond (abbreviated **msec**)**:** One-thousandth of a second.

Mirror Drawing: A task that involves learning to draw while observing hand movements reversed through a mirror. With practice, subjects show improvement in accuracy and speed.

Mispair: In the paired associate task, a nonrewarded pair that consists of one item from each of two rewarded pairs.

Modality: Of a particular kind of sensory stimulus (e.g., vision, audition).

Model: A simplified version of a physical system that captures some aspects of the physical system but eliminates others.

Momentum: A parameter sometimes used in neural networks that specifies that the weight change on the current trial should include some portion of the weight change on the previous trial; this helps to keep the weight moving in a consistent direction (positive or negative) over a series of trials and may speed learning in the network.

Mossy Fibers: Fibers arising in dentate gyrus and terminating in hippocampus.

MRI: See **Magnetic Resonance Imaging.**

msec: See **Millisecond.**

Multilayer Network: A neural network with at least one internal layer of nodes between the input and output node layers.

Multimodal: Involving more than one sensory modality.

Muscarinic Receptor: A subclass of cholinergic receptor that is also activated by the cholinergic agonist muscarine.

Negative Patterning: A conditioning paradigm in which either of two CSs predicts the US but the compound of both CSs predicts no US.

Neocortex: A form of cortex with six cell layers, found only in mammals. In mammals (particularly humans), most cerebral cortex is neocortex.

Network: A collection of interacting units, especially a neural network.

Neural Network: A group of interacting units (nodes) with adjustable connections (weights) between them; may be used as a model of similar processing between neurons (or groups of neurons) in the brain.

Neuroanatomy: The study of the anatomy of the brain with particular attention to connections between neurons or groups of neurons.

Neurology: The study of the nervous system, especially neurons.

Neuromodulator: A brain chemical that affects how neurons process incoming information.

Neuron: An information-processing cell in the brain or nervous system, which typically receives inputs from synapses on its dendrites, integrates information so received, and may become active, sending information on via its axons to other neurons.

Neuronal: Of neurons.

Neurophysiology: The study of the physiology of neurons, often with emphasis on electrical or chemical changes in neurons.

Neuropsychology: The study of the biological and neuronal basis of behavior, especially how brain injury or abnormality affects behavior.

Neuroradiography: Techniques for producing pictures of the structure or activity of the nervous system, especially the brain.

Neuroscience: The study of the brain and nervous system with particular attention to how neurons interact and function.

Neurotoxin: A chemical that, when injected into the brain, destroys neurons near the injection site.

Neurotransmitter: A brain chemical released by one neuron that may activate the receptor of another neuron and cause activation there; neurotransmitters thus carry messages between neurons.

Nicotinic Receptor: A subclass of cholinergic receptor that is also activated by the cholinergic agonist nicotine.

Node: A processing unit in a neural network that receives inputs, integrates them, and may become active and produce output; may be related to a neuron.

Nonmonotonic Development of the Stimulus Generalization Gradient: In conditioning, the finding of a broad generalization gradient early in training that is sharpened as training progresses.

Nonpairs: In the paired associate task, stimulus pairs consisting of one element from a rewarded pair and one element that is never part of a rewarded pair.

Novelty: In a network, the degree of difference between a current input pattern and all previously stored patterns; in an autoassociator or autoencoder, novelty can be estimated as the degree to which the output pattern differs from the input pattern (for a familiar, well-stored pattern, input and output patterns should be identical).

Nucleus Basalis: A structure within the basal forebrain that projects acetylcholine to cortex and amygdala.

Occasion Setting: A phenomenon in which a stimulus (called an *occasion-setter*) can mediate the association between a CS and US without itself entering into association with the US.

Olfaction: The sense of smell.

Olfactory: Of smell.

Olfactory Bulb: A region of the brain that receives inputs from olfactory receptor cells and projects to the olfactory cortex.

One-Layer Network: A neural network in which input nodes are connected to output nodes via a single layer of associative weights.

Output Node: A node in a neural network that sends output to an external target rather than to another node in the network.

Output Pattern: The pattern of activations produced by the output layer of a network.

Output Rule: The rule specifying how a node's activation level should be converted into a node output.

Overgeneralization: A tendency to generalize from one stimulus to other stimuli that are not sufficiently similar to warrant the same response.

Overtraining Reversal Effect: In conditioning, the finding that learning to reverse a discrimination can be facilitated if the original discrimination is overtrained, that is, trained for many more trials than are needed to acquire the desired responses.

Paired Associate Learning: A learning task that involves learning to associate arbitrary pairs of stimuli; certain pairs of stimuli are rewarded, but recombinations of these stimuli are not.

Paleocortex: A simple form of cortex with only two cell layers, found in reptiles and birds and in some areas of mammalian cortex.

Paradigm: The logical structure underlying an experiment independent of the particular stimuli used, the particular species tested, etc. For example, latent inhibition is a paradigm in which prior exposure to a stimulus is followed by learning to respond to that stimulus.

Paragraph Delayed Recall: A neuropsychological test of memory; the experimenter reads a short story and the subject is asked to repeat it after a delay of 5–15 minutes. Points are given for each item of the story that the subject correctly recalls.

Parahippocampal Cortex: An area of cortex lying near the entorhinal cortex and sometimes classed as part of the parahippocampal region.

Parahippocampal Region: The cortical areas lying near the hippocampus, including entorhinal cortex, perirhinal cortex and parahippocampal cortex.

Parallel Distributed Processing (abbreviated **PDP**)**:** A synonym for connectionism.

Parallel Fibers: A pathway by which sensory information reaches neurons in the cerebellum.

Parameter: A variable in an experiment or in a network that may be altered according to current needs (e.g., the number of CS exposures or the number of internal-layer nodes).

Pattern Completion: The ability of network (especially an autoassociative network) to take a partial or noisy version of a stored pattern as input and produce output that is the original stored version.

Pattern Recognition: The ability of a network (especially an autoassociative network) to take an arbitrary input and produce output that is the most similar stored pattern, thus "recognizing" the input as a distorted version of the stored pattern.

Pavlovian Conditioning: See **Classical Conditioning.**

PDP: See **Parallel Distributed Processing.**

Perceptron: An early name for a class of neural networks.

Perceptual Learning: A task in which subjects see progressively less fragmented drawings until they can identify the object; on subsequent trials, subjects can recognize the object on the basis of a more incomplete version.

Perforant Path: The fiber pathway from entorhinal cortex to hippocampus, which passes through (perforates) the intervening dentate gyrus.

Periallocortex: Cortex that is intermediate in structure between two-layer allocortex and six-layer neocortex, including the entorhinal cortex.

Perirhinal Cortex: An area of cortex lying near the entorhinal cortex and sometimes classed as part of the parahippocampal region.

Phasic: Of short duration, as a CS.

Phone: Any speech sound.

Phoneme: The smallest meaningful unit of speech in a language.

Physostigmine: A drug that acts as a cholinergic agonist by interfering with the processes that clean extra ACh out of the synapse and thus increasing the opportunity for ACh to activate the postsynaptic neuron.

Physostigmine Model: A variant of the cortico-hippocampal model in which the learning rate in the hippocampal region is inflated to simulate the effects of the cholinergic agonist physostigmine.

Piriform Cortex: See **Primary Olfactory Cortex**.

Piriform Model: A model of piriform (olfactory) cortex, proposed by R. Granger and colleagues, that assumes that the piriform cortex is capable of performing hierarchical clustering of odor inputs.

Place Cells: Neurons in the hippocampus that become active when the animal is in a particular region of space.

Plaques: In Alzheimer's disease, dense deposits outside and around neurons.

Plasticity: The ability of synapses to change so that firing in one neuron is more likely to affect activation of another neuron.

Polymodal: Involving more than one sensory modality.

Postrhinal Cortex: An area in the parahippocampal region of rats corresponding to the parahippocampal cortex in primates.

Postsynaptic Neuron: A neuron lying on the receiving end of a synapse.

Predictive Autoencoder: A variant on the autoencoder that includes additional output nodes to encode the expected reinforcement (or classification), given the current inputs.

Preparation: A particular learning system (e.g., rabbit eyeblink conditioning) that is used to refer both to the species and the response being learned.

PRER Lesion: Lesion of the parahippocampal region, including entorhinal cortex.

Presynaptic Neuron: A neuron that releases neurotransmitter into a synapse.

Primary Auditory Cortex (abbreviated **A1**)**:** The area of cortex where the first cortical processing of auditory input occurs; located in the temporal lobes in humans.

Primary Motor Cortex (abbreviated **M1**)**:** The area of cortex where simple motor movement commands are generated and projected to muscles.

Primary Olfactory Cortex (also called **Piriform Cortex**)**:** The area of cortex where the first cortical processing of odor input occurs.

Primary Sensory Cortex: The areas of cortex where the first cortical processing of sensory input occurs.

Primary Somatosensory Cortex (abbreviated **S1**)**:** The area of cortex where the first cortical processing of somatosensory (touch) input occurs; located near the top of the brain in humans.

Primary Visual Cortex (abbreviated **V1**)**:** The area of cortex where the first cortical processing of visual input occurs; located in the rear of the brain in humans.

Priming: An effect in which prior exposure to a stimulus affects the speed at which that same stimulus is subsequently recognized or processed.

Principal Components Analysis: A statistical technique for extracting the features of a data set that contain the most information and compressing or ignoring other, redundant features.

Principal Neurons: The neurons in a given brain region that are largely responsible for collecting input (especially from other brain regions), processing it, and passing it on to other brain regions. In most areas of cortex and in hippocampus, pyramidal neurons are the principal neurons; in dentate gyrus, granule cells are the principal neurons. Compare with interneurons, which collect and distribute information over local areas.

Procedural Memory: The class of memories that are incrementally acquired over many trials and may not be subject to conscious recollection (e.g., skills).

Projection: A connection from one brain region to another, typically formed by the axons of pyramidal neurons in the originating region synapsing on the dendrites of pyramidal neurons in the target region.

Psychogenic Amnesia: A kind of amnesia in which individuals may forget their past and identity. Usually due to psychological, not physical, trauma, psychogenic amnesia often resolves with time.

Punishment: An event or object that a subject seeks to avoid during the course of an experiment (e.g., shock).

Pyramidal Neuron: A kind of neuron that is generally involved in collecting input from widely divergent sources, processing information, and passing it on to other neurons in other brain areas. Compare with interneuron, which collects and distributes information over a local area.

Receptor: A region on the surface of a neuron that can be activated by a particular neurotransmitter, leading to a sequence of chemical and electrical changes within the neuron.

Recoding: Synonymous with rerepresentation.

Recurrent Collaterals: Connections from a neuron to its neighbors, as opposed to output processes that leave the brain region or contact other cell types.

Redundancy: The degree to which two stimuli or events reliably co-occur and are equally predictive of future reinforcement; high redundancy means that the stimuli always co-occur and can profitably be represented as two aspects of a single compound stimulus.

Reflex: A response to an external stimulus that is innate to an animal (or human) and does not have to be learned, such as a leg flexion in response to a foot shock or an eyeblink in response to a corneal airpuff; the stimulus that evokes such a reflexive response can serve as the unconditioned stimulus (US) in a classical conditioning experiment.

Reinforcement: An event that can serve to modify behavior, such as a reward or punishment.

Reinforcement Modulation Theories: Theories of learning that emphasize that the ability of the reinforcement (e.g., US) to drive learning depends on how unexpected it is, given all the information (e.g., CSs) present.

Representation: A scheme for relating events in the external world inside a neural network (or brain).

Representational Distortion: Altering various aspects of a representation, especially to emphasize "important" aspects while deemphasizing "less important" aspects.

Representational Weights: In a multilayer neural network, the lower layer of weights that connects input nodes to internal-layer nodes, thus specifying what representation an input pattern should evoke across the internal layer.

Rerepresentation: Forming a new representation, especially one that is more appropriate to the task at hand.

Rescorla-Wagner Model: A model of conditioning that embeds the Widrow-Hoff learning rule and assumes that CSs compete with one another for associative strength according to their informational value.

Retrograde Amnesia: A form of amnesia in which older memories are lost.

Reversal: In conditioning, a paradigm in which discrimination learning (e.g., A+, B−) is followed by learning opposite responses to the same stimuli (e.g., B+, A−).

Reward: An event or object that a subject seeks to obtain during the course of the experiment (e.g., food).

Runaway Excitation: In neural networks, a phenomenon in which activation of a subset of nodes results in activation of all the nodes to which they connect.

Runaway Synaptic Modification: In neural networks, synaptic modification that occurs during runaway excitation. If storage occurs while all nodes are active, then future activation of any one node may be enough to activate every node in the network.

S1: See **Primary Somatosensory Cortex.**

Salience: Effectiveness of a stimulus in eliciting attention or other processing resources.

Saporin: A neurotoxin that selectively destroys neurons that contain acetylcholine without damaging other kinds of neurons in the same area or damaging fibers of passage.

Schmajuk-DiCarlo Model (S-D Model): A neural network model of hippocampal-region function, proposed by N. Schmajuk and J. DiCarlo, that assumes that the hippocampal region is essential for implementing some aspects of the Rescorla-Wagner model (specifically, the ability to predict the US on the basis of all available cues) and also for forming new stimulus configurations in cortex. Simple learning to predict the US on the basis of individual CSs is assumed to occur in the cerebellum and can survive hippocampal-region damage.

Scopolamine: A drug that acts as a cholinergic antagonist, blocking cholinergic receptors and thus reducing opportunities for ACh to activate the postsynaptic neuron.

Scopolamine Model: A variant of the cortico-hippocampal model in which the learning rate in the hippocampal region is lowered to simulate the effects of the cholinergic antagonist scopolamine.

S-D Model: See **Schmajuk-DiCarlo Model.**

Self-Organizing Feature Map: A network that forms a topographic representation (map) of the input across its nodes.

Self-Organizing Network: A network that is capable of unsupervised learning.

Semantic Memory: A subdivision of declarative memory that includes memory for facts, such as vocabulary items or general knowledge about the world.

Sensory Cortex: An area of cortex devoted to processing (unimodal or polymodal) sensory cortex; compared with association cortex that is devoted to processing more abstract information such as goals and plans.

Sensory Modality: See **Modality.**

Sensory Modulation Theories: Theories of learning that emphasize the ability of CSs to enter into new associations, based on how much they add to the overall ability to predict reinforcement.

Sensory Preconditioning: A conditioning paradigm in which prior exposure to a compound of two stimuli (A and B) increases the amount that subsequent training about A will transfer to B.

Septal: Of the septum.

Septohippocampal Projection: The projection from medial septum to hippocampus, consisting of cholinergic and GABAergic fibers.

Septum: A collective term for the lateral septum and medial septum.

Sham Control: In an animal lesion experiment, a sham control is given the same surgical procedure but without the lesion. This allows the experimenter to deduce that any abnormalities in the lesioned animals are truly due to the absence of the lesioned structure and not simply to the surgical procedure itself.

Short-Term Memory: Short-duration (seconds to minutes) memory, typically lost if attention is diverted.

Sigmoidal: S-shaped. A sigmoidal activation function means that a node output is close to zero for a range of low activation values, climbs in a near-linear fashion for intermediate activation values, and then stabilizes close to 1.0 for a range of high activation values.

Simulation Run: One experiment with a single neural network, from initialization through learning. Typically, results with neural network models record the averaged performance of a number of independently initialized simulation runs.

Simultaneous Odor Discrimination: Task in which a rat is presented with two odors coming simultaneously from two odor ports and must poke its nose into the port delivering the correct odor.

Single-Layer Network: A neural network in which input nodes connect directly to output nodes via a single layer of associative weights.

Sit Control: In an experiment involving exposure to one or more stimuli, a sit control is a subject that is given equivalent time in the experimental chamber but without any exposure to the stimuli.

Somatosensory: Of the sense of touch.

Source Amnesia: A form of amnesia in which an individual may remember a piece of information but not the spatial or temporal context in which that information was learned.

Specificity: The ability to map similar stimuli to different responses, suppressing the tendency to generalize between them.

Spectrogram: See **Speech Spectrogram.**

Speech Spectrogram: A figure plotting the different sound frequencies in a speech event as a function of time.

Stimulus (plural: **Stimuli**)**:** An event (especially a sensory event) that is processed by neurons in the brain (or nodes in a neural network).

Stimulus Configuration: See **Configuration.**

Stimulus Generalization Gradient: See **Generalization Gradient.**

Stimulus Interval Effects: In conditioning, a class of phenomena in which the timing of stimuli is particularly important, such as trace conditioning.

Stimulus-Meaning Learning: Learning an association between a stimulus and a salient future event or outcome (e.g., a reinforcer).

Stimulus Representation: See **Representation.**

Stimulus Selection: The process by which individual stimuli are tuned in or tuned out of attention or processing.

Stimulus-Stimulus Learning: Learning associations between two stimuli in the absence of (or independently of) explicit reinforcement.

Stop Consonants: Consonants such as /t/, /p/, and /b/ that involve a brief period of silence in the corresponding spectrogram.

Storage: In a network, the process by which a pattern is encoded by changing associative weights between nodes; in a brain, the process whereby information is encoded by altering synaptic connections between neurons.

Stratum Lacunosum-Moleculare: The layer of the hippocampus where extra-hippocampal inputs synapse onto the dendrites of pyramidal cells.

Stratum Pyramidale: The layer of the hippocampus containing pyramidal cell bodies.

Stratum Radiatum: The layer of the hippocampus where recurrent collaterals from other areas of hippocampus synapse onto the dendrites of pyramidal cells.

Stroke: A neurological condition that occurs when blood flow is interrupted, through either occlusion (blockage) or rupture of a blood vessel; structures downstream that depend on the blood vessel to supply oxygen and nutrients will be deprived and may die.

Subcortical: Having to do with the structures lying beneath the cerebral cortex in the brain.

Subiculum: A structure within the hippocampal region that lies between hippocampus and entorhinal cortex and may provide an output pathway from hippocampal region to subcortical structures such as amygdala.

Substrate: The brain regions, cells, or processes that underlie a particular behavior or function.

Successive Odor Discrimination: A task in which a rat is presented with one odor coming from an odor port; if the odor has been designated as rewarded, the rat should poke its nose into the odor port to obtain this reward; if the odor has been designated as nonrewarded, then the rat should remove its nose from the port area to initiate the next trial and the next odor.

Superficial Layers: In cortex, the cell layers closest to the surface.

Supervised Learning: Learning in which an external system (sometimes called a teaching input) monitors the response and generates an error measure, which can be used to guide learning. Error-correction learning (e.g., error backpropagation and the Widrow-Hoff rule) is a form of supervised learning.

Synapse: A small gap between neurons; a presynaptic neuron releases neurotransmitter into the synapse, where it may activate receptors in the postsynaptic neuron.

Synaptic Strength: The efficacy of a connection between two neurons.

Systemic Administration: Delivering a drug to the entire brain (as via injection into the blood or ventricles), as opposed to local administration by injection directly into a particular brain region.

Tacrine: A drug (brand name Cognex) that acts as a cholinergic agonist by interfering with the processes that clean extra ACh out of the synapse. Originally marketed as a drug to relieve the symptoms of Alzheimer's disease, Tacrine is no longer prescribed, owing to severe side effects, including liver failure.

Tangles: In Alzheimer's disease, twisted strands of fiber that accumulate inside neurons.

Taxonomy: System for classification.

Teaching Input: A special input to a neural network that defines the desired output for one or more nodes.

Temporal Lobes: The region of the brain in each hemisphere lying under the temples and ears.

Thalamus: A brain region that serves as a way station for all sensory information (except olfaction) to reach primary sensory cortex.

Theta Rhythm: A phenomenon in which large numbers of neurons begin to fire in synchronous bursts, approximately 4–8 times a second; associated with exploratory or learning behaviors.

Threshold: A parameter that is sometimes used in neural networks specifying the minimal level of node activation required before the node can become active.

Tonic: Prolonged, as a contextual stimulus.

Topographic: A form of representation in which physically similar inputs evoke activity in nodes (or neurons) that are adjacent in the network (or brain).

Trace Conditioning: A conditioning paradigm in which the CS occurs before the US but stops before the US arrives, leaving a short interval during which a memory, or "trace," of the CS must be maintained.

Transduce: To change energy from one form to another—for example, from chemical stimuli (odors) into electrical impulses (neuronal activity).

Transition: In speech, the change from one phoneme to another.

Trauma: Injury; especially a physical injury resulting in long-lasting behavioral effects.

Trial: In conditioning, the sequence of events consisting of CS presentation, CR generation, and US arrival or nonarrival. In neural network models, trials may also include intermixed presentation of the context alone, without any CS or US, to simulate the time the subject spends in the conditioning apparatus between presentations of CSs.

Unconditioned Response (abbreviated **UR):** A reflexive response to an unconditioned stimulus—for example, a protective eyeblink in response to a corneal airpuff or a leg flexion in response to a foot shock.

Unconditioned Stimulus (abbreviated **US):** A stimulus that evokes a reflexive response—for example, a corneal airpuff that evokes a protective eyeblink or a foot shock that evokes a leg flexion pulling the foot away.

Unilateral: Of or involving a single side (hemisphere) of the brain, as in a unilateral lesion; compare with **Bilateral.**

Unimodal: Involving a single sensory modality.

Unreinforced Learning: See **Latent Learning.**

Unsupervised Learning: Learning in which there is no external system to evaluate performance; instead, the system may develop its own strategy for representing information. Variants are autoassociative networks and competitive networks.

UR: See **Unconditioned Response.**

US: See **Unconditioned Stimulus.**

V1: See **Primary Visual Cortex.**

Water Maze: A task in which an animal (typically a rat) is placed in a circular pool filled with opaque liquid and learns to escape to a hidden platform somewhere in the pool.

Weight: In a neural network, a number specifying the strength or efficacy of a connection between two nodes. A positive number specifies an excitatory connection; a negative number specifies an inhibitory connection.

Widrow-Hoff Rule: A neural network learning rule that specifies that the connection between two nodes should be changed proportionally to the error between the desired output and the actual output; applies only to networks with a single layer of weights and a well-defined desired output.

Working Memory: The form of memory that contains information relevant to the task at hand (e.g., task rules, goals, recent responses).

XOR Task: See **Exclusive-Or Task.**