Brain Report
Philosophy of the Mind – Brain and Consciousness
Dr. Francisco J. Collazo Beauchamp
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Introduction

The report is based on the Philosophy of the Mind Course from the Teaching Company taught by Professor Patrick Grim, a Distinguished Professor of Philosophy at the State University of New York. The course addresses the brain, consciousness and thinking machines (artificial intelligence). It describes the connection of the mind and soul in the pineal gland of the brain; it is the pivot point of the mind and body connection.

The course is comprised of 24 lessons and notes were taken during the course. A total of 224 hours were devoted to this course, 80 days. The report is organized into four parts and two attachments. Part I is an overview of the Brain functions, Part II is a summary of the great philosopher s who have contributed to the philosophy of mind soul merge dilemma, Part III is the glossary of terms, and Part IV is the Bibliography where the information was originated. Attachment I is Descartes Executive Summary outlining all his scientific accomplishments. Attachment II is the Philosophical Views of Descartes and other philosophers. The knowledge acquired during this course is substantial; at least it measured how much I do not know about the brain.

I am beginning to see the end of the tunnel and have learned the basics of how the brain functions and solved the dilemma of the body mind connection by the pineal gland in the brain. I have discovered how much I do not know. The more I dig into the course material it convinces me I have a lot to learn about many things.

One of the highlights is that Aristotle's thought mistakenly that the seat of the heart was to control emotions, and the brain was an air conditioning system for the blood. Aristotle's school came to be known as the Peripatetic ("walking" or "strolling") school. He taught while walking and strolling. In astronomy, Aristotle proposed a finite, spherical universe, with the earth at its center later changed by Copernicus as the Sun is the center of the universe. He also held that heavier bodies of a given material fall faster than lighter ones when their shapes are the same, a mistaken view that was accepted as fact until the Italian physicist and astronomer Galileo conducted his experiment with weights dropped from the Leaning Tower of Pisa. One of Aristotle's thoughts was: "Very low" worms and flies come from rotting fruit or manure by "spontaneous generation."

Chairs were invented in Egypt in 2650 BC.

To the reader: I hope you enjoy the report.

Part I - Executive Summary of the Brain

Brain Overview

The human brain has three major structural components: the large dome-shaped cerebrum (top), the smaller somewhat spherical cerebellum (lower right), and the brainstem (center).

Prominent in the brainstem are the medulla oblongata (the egg-shaped enlargement at center) and the thalamus (between the medulla and the cerebrum).

The cerebrum is responsible for intelligence and reasoning and helps maintain balance and posture.

The medulla is involved in maintaining involuntary functions such as respiration.

The thalamus acts as a relay center for electrical impulses traveling to and from the cerebral cortex.

Brain Functions: The brain is the control center for movement, sleep, hunger, thirst, and virtually every other vital activity necessary to survival.

- All human emotions—including love, hate, fear, anger, elation, and sadness—are controlled by the brain.
- It also receives and interprets the countless signals that are sent to it from other parts of the body and from the external environment.
- The brain makes us conscious, emotional, and intelligent.

Brain Anatomy

Weight: 1.3-kg (3-lb) mass

Color: Pinkish-gray jellylike tissue made up of approximately 100 billion nerve cells, or neurons

Neuroglia (supporting tissue) cells

Vascular (blood-carrying) and other tissues

Between the brain and the cranium—the part of the skull that directly covers the brain—is three protective membranes, or meninges.

Dura mater - the outermost membrane is the toughest and thickest.

Arachnoids' layer - below the dura mater is a middle membrane.

Pia mater, the innermost membrane, consists mainly of small blood vessels and follows the contours of the surface of the brain.

Cerebrospinal fluid, a clear liquid bathes the entire brain and fills a series of four cavities called ventricles, near the center of the brain.

- The cerebrospinal fluid protects the internal portion of the brain from varying pressures and transports chemical substances within the nervous system.

Three interconnecting parts:

From the outside, the brain appears as three distinct but connected parts:

- The cerebrum (the Latin word for brain)—two large, almost symmetrical hemispheres.
- The cerebellum ("little brain")—two smaller hemispheres located at the back of the cerebrum.
- The brain stem—a central core that gradually becomes the spinal cord, exiting the skull through an opening at its base called the foramen magnum.
- Two other major parts of the brain, the thalamus and the hypothalamus, lie in the midline above the brain stem underneath the cerebellum.

The brain and the spinal cord together make up the central nervous system, which communicates with the rest of the body through the peripheral nervous system.

- The peripheral nervous system consists of 12 pairs of cranial nerves extending from the cerebrum and brain stem.
- A system of other nerves branching throughout the body from the spinal cord
- The autonomic nervous system, which regulates vital functions not under conscious control, such as the activity of the heart muscle, smooth muscle (involuntary muscle found in the skin, blood vessels, and internal organs), and glands

The Cerebellum

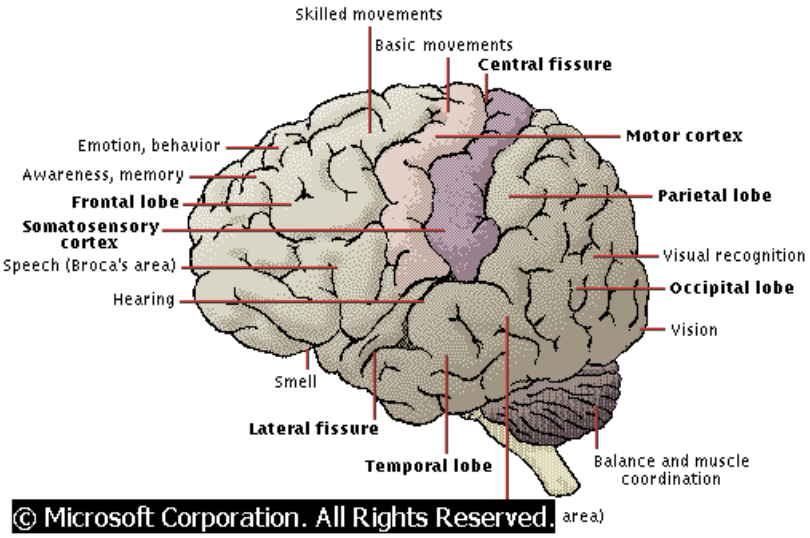
Functions of the Cerebral Cortex

Many motor and sensory functions have been "mapped" to specific areas of the cerebral cortex, some of which are indicated here. In general, these areas exist in both hemispheres of the cerebrum, each serving the opposite side of the body.

Less well defined are the areas of association, located mainly in the frontal cortex, operative in functions of thought and emotion and responsible for linking input from different senses.

The areas of language are an exception:

- Wernicke's area - It is concerned with the comprehension of spoken language.
- Broca's area - The governing and the production of speech have been pinpointed in the cortex.



Most high-level brain functions take place in the cerebrum.

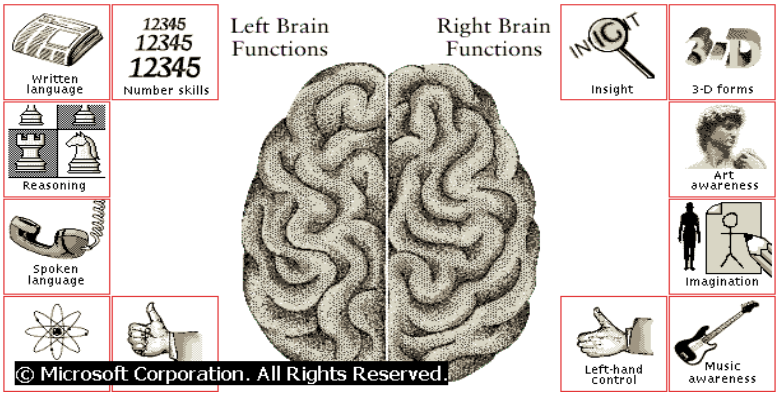
- Its two large hemispheres make up approximately 85 percent of the brain's weight.
- The exterior surface of the cerebrum, the cerebral cortex, is a convoluted, or folded, grayish layer of cell bodies known as the gray matter.
- The gray matter covers an underlying mass of fibers called the white matter.
- The convolutions are made up of:
  - Gyri - Ridge like bulges
  - Sulci - Small grooves.
  - Fissures - Larger grooves called fissures.
  - Approximately two-thirds of the cortical surface is hidden in the folds of the sulci.
  - The extensive convolutions enable a very large surface area of brain cortex—about 1.5 m^2 (16 ft^2) in an adult—to fit within the cranium.
  - The pattern of these convolutions is similar, although not identical, in all humans.

The two cerebral hemispheres are partially separated from each other by a deep fold known as the longitudinal fissure.

- Communication between the two hemispheres is through several concentrated bundles of axons, called commissures, the largest of which is the corpus callosum.
- Several major sulci divide the cortex into distinguishable regions.
- The central sulcus, or rolandic fissure, runs from the middle of the top of each hemisphere downward, forward, and toward another major sulcus, the lateral (“side”), or Sylvain, sulcus.
- These and other sulci and gyri divide the cerebrum into five lobes: the frontal, parietal, temporal, and occipital lobes and the insula.

The limbic system is a group of brain structures that play a role in memory, emotion, and motivation.

- The hippocampus and surrounding structures are thought to play crucial roles in the encoding and retrieval of memories.
- The amygdala, a structure that helps to regulate emotion, seems to play a role in emotional memories.



Left and Right Brain Functions

Although the cerebrum is symmetrical in structure, with two lobes emerging from the brain stem and matching motor and sensory areas in each, certain intellectual functions are restricted to one hemisphere.

- A person's dominant hemisphere is usually occupied with language and logical operations, while the other hemisphere controls emotion and artistic and spatial skills.
- In nearly all right-handed and many left-handed people, the left hemisphere is dominant.

Left Brain Functions	Right brain functions
Number Skills	Insight
Written Language processing	3D forms
Reasoning	Art awareness
Spoken Language	Imagination
Scientific skills	Music awareness
Right hand control	Left Hand control

The frontal lobe is the largest of the five and consists of the cortex in front of the central sulcus. Broca's area, a part of the cortex related to production of speech, is located in the frontal lobe. The parietal lobe consists of the cortex behind the central sulcus to a sulcus near the back of the cerebrum known as the parieto-occipital sulcus. The parieto-occipital sulcus, in turn, forms the front border of the occipital lobe, which is the rearmost part of the cerebrum. The temporal lobe

is to the side of and below the lateral sulcus. Wernicke's area, a part of the cortex related to the understanding of language, is located in the temporal lobe. The insula lies deep within the folds of the lateral sulcus.

The cerebrum receives information from all the sense organs and sends motor commands (signals that result in activity in the muscles or glands) to other parts of the brain and the rest of the body.

- Motor commands are transmitted by the motor cortex, a strip of cerebral cortex extending from side to side across the top of the cerebrum just in front of the central sulcus.
- The sensory cortex, a parallel strip of cerebral cortex just in back of the central sulcus, receives input from the sense organs.

Many other areas of the cerebral cortex have also been mapped according to their specific functions, such as vision, hearing, speech, emotions, language, and other aspects of perceiving, thinking, and remembering.

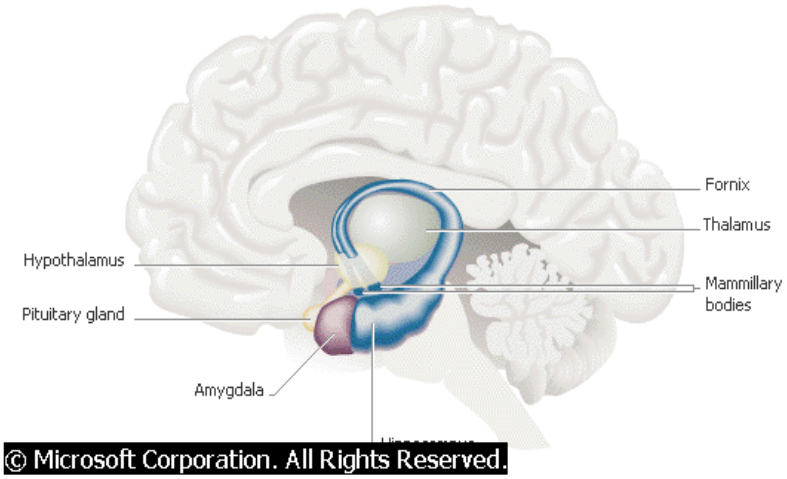
Cortical regions known as associative cortex are responsible for integrating multiple inputs, processing the information, and carrying out complex responses.

Cerebellum

The cerebellum coordinates body movements.

- Located at the lower back of the brain beneath the occipital lobes, the cerebellum is divided into two lateral (side-by-side) lobes connected by a fingerlike bundle of white fibers called the vermis.
- The outer layer, or cortex, of the cerebellum consists of fine folds called folia. As in the cerebrum, the outer layer of cortical gray matter surrounds a deeper layer of white matter and nuclei (groups of nerve cells).
- Three fiber bundles called cerebellar peduncles connect the cerebellum to the three parts of the brain stem—the midbrain, the Pons, and the medulla oblongata.
- The cerebellum coordinates voluntary movements by fine-tuning commands from the motor cortex in the cerebrum.
- The cerebellum also maintains posture and balance by controlling muscle tone and sensing the position of the limbs.
- All motor activity, from hitting a baseball to fingering a violin, depends on the cerebellum.

Thalamus and Hypothalamus



Limbic System

The limbic system is a group of brain structures that play a role in emotion, memory, and motivation.

- For example: Electrical stimulation of the amygdala in laboratory animals can provoke fear, anger, and aggression.
- The hypothalamus regulates hunger, thirst, sleep, body temperature, sexual drive, and other functions.
- The thalamus and the hypothalamus lie underneath the cerebrum and connect it to the brain stem.
- The thalamus consists of two rounded masses of gray tissue lying within the middle of the brain, between the two cerebral hemispheres.
- The thalamus is the main relay station for incoming sensory signals to the cerebral cortex and for outgoing motor signals from it.
- All sensory input to the brain, except that of the sense of smell, connects to individual nuclei of the thalamus.
- The hypothalamus lies beneath the thalamus on the midline at the base of the brain.
- It regulates or is involved directly in the control of many of the body's vital drives and activities, such as eating, drinking, temperature regulation, sleep, emotional behavior, and sexual activity.
- It also controls the function of internal body organs by means of the autonomic nervous system, interacts closely with the pituitary gland, and helps coordinate activities of the brain stem.

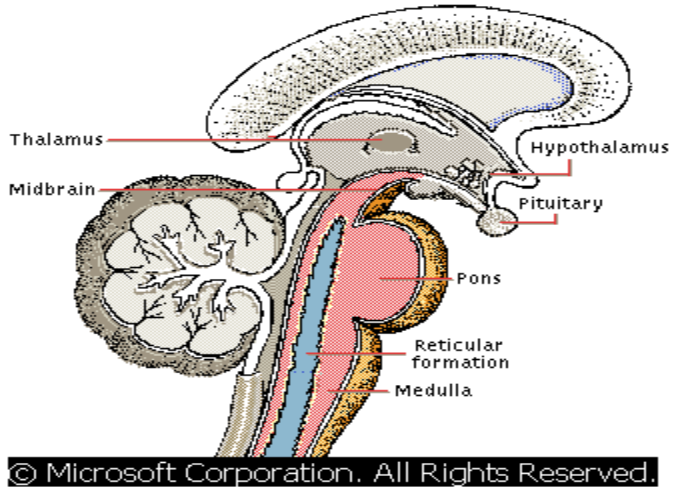
Amygdala: The structure that helps to regulate emotion, seems to play a role in emotional memories.

Fornix: Arched structure is a structure or fold in the shape of an arch, especially either of two bands of white fibers in the brain.

Pituitary gland: Pituitary Gland, master endocrine gland in vertebrate animals. The hormones secreted by the pituitary stimulate and control the functioning of almost all the other endocrine

glands in the body. Pituitary hormones also promote growth and control the water balance of the body.

Brain Stem



Structure of the Brain Stem

The brain stem, shown here in colored cross section, is the lowest part of the brain. It serves as the path for messages traveling between the upper brain and spinal cord.

- It is also the seat of basic and vital functions such as breathing, blood pressure, and heart rate, as well as reflexes like eye movement and vomiting.
- The brain stem has three main parts: the medulla, Pons, and midbrain. A canal runs longitudinally through these structures carrying cerebrospinal fluid. Also distributed along its length is a network of cells, referred to as the reticular formation that governs the state of alertness.
- The brain stem is evolutionarily the most primitive part of the brain and is responsible for sustaining the basic functions of life, such as breathing and blood pressure.
- It includes three main structures lying between and below the two cerebral hemispheres—the midbrain, Pons, and medulla oblongata.
- Pons
- Reticular formation
- Medulla

Midbrain

The topmost structure of the brain stem is the midbrain. It contains major relay stations for neurons transmitting signals to the cerebral cortex, as well as many reflex centers—pathways carrying sensory (input) information and motor (output) commands.

- Relay and reflex centers for visual and auditory (hearing) functions are located in the top portion of the midbrain.

- A pair of nuclei called the superior colliculus control reflex actions of the eye, such as blinking, opening and closing the pupil, and focusing the lens.
- A second pair of nuclei, called the inferior colliculus, control auditory reflexes, such as adjusting the ear to the volume of sound.
- At the bottom of the midbrain are reflex and relay centers relating to pain, temperature, and touch, as well as several regions associated with the control of movement, such as the red nucleus and the substantial nigra.

Pons

Continuous with and below the midbrain and directly in front of the cerebellum is a prominent bulge in the brain stem called the Pons.

- The Pons consists of large bundles of nerve fibers that connect the two halves of the cerebellum and also connect each side of the cerebellum with the opposite-side cerebral hemisphere.
- The Pons serves mainly as a relay station linking the cerebral cortex and the medulla oblongata.

Medulla Oblongata

The long, stalk like lowermost portion of the brain stem is called the medulla oblongata.

- At the top, it is continuous with the Pons and the midbrain; at the bottom, it makes a gradual transition into the spinal cord at the foramen magnum.
- Sensory and motor nerve fibers connecting the brain and the rest of the body cross over to the opposite side as they pass through the medulla.
- Thus, the left half of the brain communicates with the right half of the body and the right half of the brain with the left half of the body.

Reticular Formation

Running up the brain stem from the medulla oblongata through the Pons and the midbrain is a netlike formation of nuclei known as the reticular formation.

- The reticular formation controls respiration, cardiovascular function, digestion, levels of alertness, and patterns of sleep.
- It also determines which parts of the constant flow of sensory information into the body are received by the cerebrum.

Brain Cells

There are two main types of brain cells, neurons and neuroglia.

- Neurons are responsible for the transmission and analysis of all electrochemical communication within the brain and other parts of the nervous system.

- Each neuron is composed of a cell body called a soma, a major fiber called an axon, and a system of branches called dendrites.
- Axons, also called nerve fibers, convey electrical signals away from the soma and can be up to 1 m (3.3 ft) in length. Most axons are covered with a protective sheath of myelin, a substance made of fats and protein, which insulates the axon.
- Myelinated axons conduct neuronal signals faster than do unmyelinated axons.
- Dendrites convey electrical signals toward the soma, are shorter than axons, and are usually multiple and branching.

- Neuroglial cells are twice as numerous as neurons and account for half of the brain's weight.
- Neuroglia (from glia, Greek for “glue”) provides structural support to the neurons.
- Neuroglial cells also form myelin, guide developing neurons, take up chemicals involved in cell-to-cell communication, and contribute to the maintenance of the environment around neurons.

Cranial Nerves

Twelve pairs of cranial nerves arise symmetrically from the base of the brain and are numbered, from front to back, in the order in which they arise.

- They connect mainly with structures of the head and neck, such as the eyes, ears, nose, mouth, tongue, and throat.
- Some are motor nerves, controlling muscle movement; some are sensory nerves, conveying information from the sense organs; and others contain fibers for both sensory and motor impulses.
- The first and second pairs of cranial nerves—the olfactory (smell) nerve and the optic (vision) nerve—carry sensory information from the nose and eyes, respectively, to the undersurface of the cerebral hemispheres.
- The other ten pairs of cranial nerves originate in or end in the brain stem.

How the Brain Works

The brain functions by complex neuronal, or nerve cell, circuits. Communication between neurons is both electrical and chemical and always travels from the dendrites of a neuron, through its soma, and out its axon to the dendrites of another neuron.

- Dendrites of one neuron receive signals from the axons of other neurons through chemicals known as neurotransmitters.
- The neurotransmitters set off electrical charges in the dendrites, which then carry the signals electrochemically to the soma.
- The soma integrates the information, which is then transmitted electrochemically down the axon to its tip.
- At the tip of the axon, small, bubble like structures called vesicles release neurotransmitters that carry the signal across the synapse, or gap, between two neurons.

- There are many types of neurotransmitters, including nor-epinephrine, dopamine, and serotonin. Neurotransmitters can be excitatory (that is, they excite an electrochemical response in the dendrite receptors) or inhibitory (they block the response of the dendrite receptors).
- One neuron may communicate with thousands of other neurons, and many thousands of neurons are involved with even the simplest behavior. It is believed that these connections and their efficiency can be modified, or altered, by experience.
- Scientists have used two primary approaches to studying how the brain works. One approach is to study brain function after parts of the brain have been damaged. Functions that disappear or that are no longer normal after injury to specific regions of the brain can often be associated with the damaged areas.
- The second approach is to study the response of the brain to direct stimulation or to stimulation of various sense organs.
- Neurons are grouped by function into collections of cells called nuclei. These nuclei are connected to form sensory, motor, and other systems.
- Scientists can study the function of somato-sensory (pain and touch), motor, olfactory, visual, auditory, language, and other systems by measuring the physiological (physical and chemical) changes that occur in the brain when these senses are activated.
- For example, electroencephalography (EEG) measures the electrical activity of specific groups of neurons through electrodes attached to the surface of the skull.
  - Electrodes inserted directly into the brain can give readings of individual neurons. Changes in blood flow, glucose (sugar), or oxygen consumption in groups of active cells can also be mapped.
- Although the brain appears symmetrical, how it functions is not. Each hemisphere is specialized and dominates the other in certain functions.
  - Research has shown that hemispheric dominance is related to whether a person is predominantly right-handed or left-handed.
  - In most right-handed people, the left hemisphere processes arithmetic, language, and speech.
  - The right hemisphere interprets music, complex imagery, and spatial relationships and recognizes and expresses emotion.
  - In left-handed people, the pattern of brain organization is more variable.
- Hemispheric specialization has traditionally been studied in people who have sustained damage to the connections between the two hemispheres, as may occur with stroke, an interruption of blood flow to an area of the brain that causes the death of nerve cells in that area.
  - The division of functions between the two hemispheres has also been studied in people who have had to have the connection between the two hemispheres surgically cut in order to control severe epilepsy, a neurological disease characterized by convulsions and loss of consciousness.

Vision

- The visual system of humans is one of the most advanced sensory systems in the body. More information is conveyed visually than by any other means.
  - In addition to the structures of the eye itself, several cortical regions—collectively called primary visual and visual associative cortexes—as well as the midbrain are involved in the visual system.

- Conscious processing of visual input occurs in the primary visual cortex, but reflexive—that is, immediate and unconscious—responses occur at the superior colliculus in the midbrain.
- Associative cortical regions—specialized regions that can associate, or integrate, multiple inputs—in the parietal and frontal lobes along with parts of the temporal lobe are also involved in the processing of visual information and the establishment of visual memories.

Language

Language involves specialized cortical regions in a complex interaction that allows the brain to comprehend and communicate abstract ideas.

- The motor cortex initiates impulses that travel through the brain stem to produce audible sounds.
- Neighboring regions of motor cortex, called the supplemental motor cortex, are involved in sequencing and coordinating sounds.
- Broca's area of the frontal lobe is responsible for the sequencing of language elements for output.
- The comprehension of language is dependent upon Wernicke's area of the temporal lobe. Other cortical circuits connect these areas.

Memory

Memory is usually considered a diffusely stored associative process—that is, it puts together information from many different sources.

- Although research has failed to identify specific sites in the brain as locations of individual memories, certain brain areas are critical for memory to function.
- Immediate recall—the ability to repeat short series of words or numbers immediately after hearing them—is thought to be located in the auditory associative cortex.
- Short-term memory—the ability to retain a limited amount of information for up to an hour—is located in the deep temporal lobe.
- Long-term memory probably involves exchanges between the medial temporal lobe, various cortical regions, and the midbrain.

The frontal lobes play an important role in encoding and retrieving memories.

- For example, certain areas of the left frontal lobe seem especially active during encoding of memories, whereas those in the right frontal lobe are more active during retrieval.
- An area in the right anterior prefrontal cortex becomes active when a person is trying to retrieve a previously experienced episode. Some evidence indicates that this region may be even more active when the retrieval attempt is successful—that is, when the person not only attempts to remember but is able to remember some previous occurrence.

Biochemistry of Memory

The study of the biochemistry of memory is another exciting scientific enterprise, but one that can only be touched upon here.

- Scientists estimate that an adult human brain contains about 100 billion neurons. Each of these is connected to hundreds or thousands of other neurons, forming trillions of neural connections. Neurons communicate by chemical messengers called neurotransmitters.
- An electrical signal travels along the neuron, triggering the release of neurotransmitters at the synapse, the small gap between neurons.
- The neurotransmitters travel across the synapse and act on the next neuron by binding with protein molecules called receptors. Most scientists believe that memories are somehow stored among the brain's trillions of synapses, rather than in the neurons themselves.
- Scientists who study the biochemistry of learning and memory often focus on the marine snail Aplysia because its simple nervous system allows them to study the effects of various stimuli on specific synapses.
- A change in the snail's behavior due to learning can be correlated with a change at the level of the synapse. One exciting scientific frontier is discovering the changes in neurotransmitters that occur at the level of the synapse.
- Some studies in humans that have systematically varied the amount of glucose and insulin in the blood have shown that insulin may be the more important of the two substances for learning.

Method of Loci

One of the oldest mnemonics is the method of loci (loci is a Latin word meaning "places"). This method involves forming vivid interactive images between specific locations and items to be remembered.

You can use the method of loci to remember any set of information, such as a grocery list or points in a speech. The best strategy is to convert each item of information into a vivid mental image by putting it at a familiar location where it can be "seen" in the mind.

Peg-Word Mnemonic

The peg-word mnemonic is a method of remembering things through visual imagery. The more bizarre the images are, the more likely you will recall them. Another mnemonic that relies on the power of visual imagery is called the peg word method. There are many variations on the peg word method, but they are all based on the same general principle. People learn a series of words that serve as "pegs" on which memories can be "hung."

Peg methods such as this one permit more flexible access to information than does the method of loci. For example, if you want to recite the items backwards for some reason, you can do so just as easily as in the forward direction.

PQ4R Method

The PQ4R method is a mnemonic technique used for remembering text material. The name is itself a mnemonic device for the steps involved. If you are interested in better remembering a chapter from a textbook, you should first Preview the information by skimming quickly through the chapter and looking at the headings. The next step is to form Questions about the information. One way to do this is by simply converting headings to questions. Using this article as an example, you might ask, "What are the ways to improve memory?"

- The third step is to Read the text carefully trying to answer the questions. After reading, the next step is to reflect on the material. One way would be to create your own examples of how the principles you are reading could be applied.
- The next step is to recite the material after reading it. That is, put the book aside or look away and try to recall or to recite what you have just read. If you cannot bring it to mind now, you will have little chance later.
- The last step in PQ4R is to Review. After you have read the entire chapter, go through it again trying to recall and to summarize its main points.

Principles of Encoding, Recoding, and Retrieval

The principles of encoding, recoding, and retrieval discussed elsewhere in this article suggest other ways that memory can be improved.

- For example, encoding information in an elaborate, meaningful way helps in retention. There are many ways to encode information meaningfully. When possible, try to convert verbal information into mental images.
- When learning about events and facts, try to focus on their meaning rather than their superficial characteristics.
- Relating new information to your personal experiences or to what you already know also makes it easier to retain the information.

Memory Impairment

Amnesia means loss of memory. There are many different types of amnesias, but they fall into two major classes according to their cause:

- Functional amnesia - Functional amnesia refers to memory disorders that seem to result from psychological trauma, not an injury to the brain.
- Organic amnesia - Involves memory loss caused by specific malfunctions in the brain.
- Infantile amnesia - Refers to the fact that most people lack specific memories of the first few years of their life.

Korsakoff Syndrome

Korsakoff's syndrome, also called Korsakoff's psychosis, is a disorder that produces severe and often permanent amnesia. In this condition, years of chronic alcoholism and thiamine (vitamin B_1) deficiency cause brain damage, particularly to the thalamus, which helps process sensory information, and to the mammillary bodies, which lie beneath the thalamus. Some patients also have damage to the cortex and cerebellum.

- Most suffer from retrograde amnesia ranging from mild to severe and typically cannot remember recent experiences. The condition is also associated with other intellectual deficits, such as confusion and disorientation.
- Alzheimers disease - Amnesia also occurs in Alzheimers disease, a condition in which the neurons in the brain gradually degenerate, hindering brain function. Damage to the hippocampus and frontal lobes impairs memory. Many other types of organic amnesias exist.
- For example, in large doses, most depressant drugs can cause acute loss of memory. With severe alcohol or marijuana intoxication, people often forget events that occurred while under influence of the drug.

Autonomic Nervous System

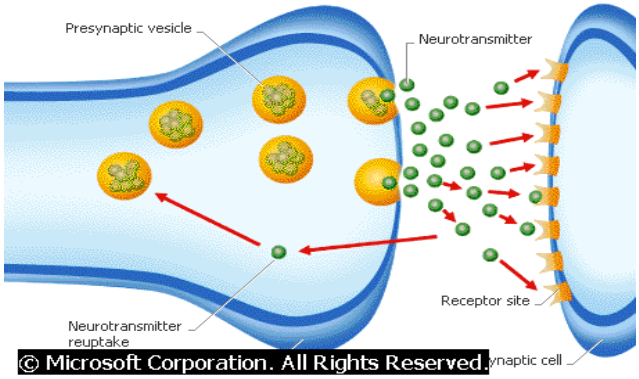
The autonomic nervous system regulates the life support systems of the body reflexively—that is, without conscious direction.

- It automatically controls the muscles of the heart, digestive system, and lungs; certain glands; and homeostasis—that is, the equilibrium of the internal environment of the body.
- The autonomic nervous system itself is controlled by nerve centers in the spinal cord and brain stem and is fine-tuned by regions higher in the brain, such as the midbrain and cortex.
- Reactions such as blushing indicate that cognitive, or thinking, centers of the brain are also involved in autonomic responses.

Retina

The optic nerve contains the retinal nerve fibers, which carry visual impulses to the brain. The retinal circulation is carried by the central artery and vein, which lie in the optic nerve. The sheath of the optic nerve communicates with the cerebral lymph spaces. Inflammation of that part of the optic nerve situated within the eye is known as optic neuritis, or papillitis; when inflammation occurs in the part of the optic nerve behind the eye, the disease is called retro bulbar neuritis. When the pressure in the skull is elevated, or increased in intracranial pressure, as in brain tumors, edema and swelling of the optic disk occur where the nerve enters the eyeball, a condition known as papilledema, or chocked disk.

Neuro-Transmitters



Neurotransmitters Cross a Synapse

In the nervous system, a message-carrying impulse travels from one end of a nerve cell to the other by means of an electrical impulse. When it reaches the terminal end of a nerve cell, the impulse triggers tiny sacs called presynaptic vesicles to release their contents, chemical messengers called neurotransmitters. The neurotransmitters float across the synapse, or gap between adjacent nerve cells. When they reach the neighboring nerve cell, the neurotransmitters fit into specialized receptor sites much as a key fits into a lock, causing that nerve cell to "fire," or generate an electric message-carrying impulse. As the message continues through the nervous system, the presynaptic cell absorbs the excess neurotransmitters, and repackages them in presynaptic vesicles in a process called neurotransmitter reuptake.

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Brain Disorders

The brain is guarded by several highly developed protective mechanisms. The bony cranium, the surrounding meninges, and the cerebrospinal fluid all contribute to the mechanical protection of the brain.

- In addition, a filtration system called the blood-brain barrier protects the brain from exposure to potentially harmful substances carried in the bloodstream.

- Brain disorders have a wide range of causes, including head injury, stroke, bacterial diseases, complex chemical imbalances, and changes associated with aging.

Head Injury

Head injury can initiate a cascade of damaging events. After a blow to the head, a person may be stunned or may become unconscious for a moment. This injury, called a concussion, usually leaves no permanent damage.

- If the blow is more severe and hemorrhage (excessive bleeding) and swelling occur, however, severe headache, dizziness, paralysis, a convulsion, or temporary blindness may result, depending on the area of the brain affected.
- Damage to the cerebrum can also result in profound personality changes.
- Damage to Broca's area in the frontal lobe causes difficulty in speaking and writing, a problem known as Broca's aphasia.
- Injury to Wernicke's area in the left temporal lobe results in an inability to comprehend spoken language, called Wernicke's aphasia.
- An injury or disturbance to a part of the hypothalamus may cause a variety of different symptoms, such as:
  - Loss of appetite with an extreme drop in body weight.
  - Increase in appetite leading to obesity.
  - Extraordinary thirst with excessive urination (diabetes insipidus).
  - Failure in body-temperature control, resulting in either low temperature (hypothermia) or high temperature (fever).
  - Excessive emotionality.
  - Uncontrolled anger or aggression.
  - If the relationship between the hypothalamus and the pituitary gland is damaged, other vital bodily functions may be disturbed, such as sexual function, metabolism, and cardiovascular activity.
- Injury to the brain stem is even more serious because it houses the nerve centers that control breathing and heart action.
- Damage to the medulla oblongata usually results in immediate death.

Stroke

A stroke is damage to the brain due to an interruption in blood flow. The interruption may be caused by a blood clot (see Embolism; Thrombosis), constriction of a blood vessel, or rupture of a vessel accompanied by bleeding.

- A pouch-like expansion of the wall of a blood vessel, called an aneurysm, may weaken and burst, for example, because of high blood pressure.
- Sufficient quantities of glucose and oxygen, transported through the bloodstream, are needed to keep nerve cells alive.
- When the blood supply to a small part of the brain is interrupted, the cells in that area die and the function of the area is lost.

- A massive stroke can cause a one-sided paralysis (hemiplegic) and sensory loss on the side of the body opposite the hemisphere damaged by the stroke.

Brain Diseases

- Science Source/Photo Researchers, Inc. D. Rosenbaum/Photo take NYC
- Epilepsy is a broad term for a variety of brain disorders characterized by seizures, or convulsions. Epilepsy can result from a direct injury to the brain at birth or from a metabolic disturbance in the brain at any time later in life.
- Some brain diseases, such as multiple sclerosis and Parkinson disease, are progressive, becoming worse over time.
- Multiple sclerosis damages the myelin sheath around axons in the brain and spinal cord. As a result, the affected axons cannot transmit nerve impulses properly.
- Parkinson's disease destroys the cells of the substantial nigra in the midbrain, resulting in a deficiency in the neurotransmitter dopamine that affects motor functions.
- Cerebral palsy is a broad term for brain damage sustained close to birth that permanently affects motor function. The damage may take place either in the developing fetus, during birth, or just after birth and is the result of the faulty development or breaking down of motor pathways. Cerebral palsy is non-progressive—that is, it does not worsen with time.
- A bacterial infection in the cerebrum (Encephalitis) or in the coverings of the brain (Meningitis), swelling of the brain (Edema), or an abnormal growth of healthy brain tissue (Tumor) can all cause an increase in intracranial pressure and result in serious damage to the brain.
- Scientists are finding that certain brain chemical imbalances are associated with mental illness such as schizophrenia and depression. Such findings have changed scientific understanding of mental health and have resulted in new treatments that chemically correct these imbalances.
- During childhood development, the brain is particularly susceptible to damage because of the rapid growth and reorganization of nerve connections. Problems that originate in the immature brain can appear as epilepsy or other brain-function problems in adulthood.
- Several neurological problems are common in aging. Alzheimer's disease damages many areas of the brain, including the frontal, temporal, and parietal lobes. The brain tissue of people with Alzheimer's disease shows characteristic patterns of damaged neurons, known as plaques and tangles. Alzheimer's disease produces a progressive dementia (Senile Dementia), characterized by symptoms such as failing attention and memory, loss of mathematical ability, irritability, and poor orientation in space and time.

Brain Imaging

Surface of the Brain

A magnetic resonance imaging (MRI) scan of the human brain reveals the contours of one of the brain's hemispheres.

- The gyri, or ridges, appear in red.
- The sulci, or valleys, are shown in blue.
- Each person has slightly different patterns of gyri and sulci, which reflect individual differences in brain development.
- Nancy C. Andreasen M.D., PhD
- Several commonly used diagnostic methods give images of the brain without invading the skull.
- Some portray anatomy—that is, the structure of the brain—whereas others measure brain function. Two or more methods may be used to complement each other, together providing a more complete picture than would be possible by one method alone.
- 1980's: Magnetic resonance imaging (MRI), introduced in the early 1980s, beams high-frequency radio waves into the brain in a highly magnetized field that causes the protons that form the nuclei of hydrogen atoms in the brain to reemit the radio waves.
  - The reemitted radio waves are analyzed by computer to create thin cross-sectional images of the brain.
  - The MRI provides the most detailed images of the brain and is safer than imaging methods that use X rays.
  - The MRI is a lengthy process and also cannot be used with people who have pacemakers or metal implants, both of which are adversely affected by the magnetic field.
- Computed tomography (CT), also known as CT scans, developed in the early 1970s.
  - This imaging method X-rays the brain from many different angles, feeding the information into a computer that produces a series of cross-sectional images.
  - CT is particularly useful for diagnosing blood clots and brain tumors.
  - It is a much quicker process than magnetic resonance imaging and is therefore advantageous in certain situations—for example, with people who are extremely ill.

- Positron Emission Tomography: This positron emission tomography (PET) scan of the brain shows the activity of brain cells in the resting state and during three types of auditory stimulation.
- PET uses radioactive substances introduced into the brain to measure such brain functions as cerebral metabolism, blood flow and volume, oxygen use, and the formation of neurotransmitters.
- This imaging method collects data from many different angles, feeding the information into a computer that produces a series of cross-sectional images.
- (Dr. John Mazziotta ET AL/Neurology/Science Source/Photo Researchers, Inc.)
- Changes in brain function due to brain disorders can be visualized in several ways.
  - Magnetic resonance spectroscopy measures the concentration of specific chemical compounds in the brain that may change during specific behaviors.
  - Functional magnetic resonance imaging (MRI) maps changes in oxygen concentration that correspond to nerve cell activity.
- 1970's: Positron emission tomography (PET) was developed in the mid-1970s, uses computed tomography to visualize radioactive tracers (Isotopic Tracer), radioactive substances introduced into the brain intravenously or by inhalation.
- PET can measure such brain functions as cerebral metabolism, blood flow and volume, oxygen use, and the formation of neurotransmitters.
- Single photon emission computed tomography (SPECT), developed in the 1950s and 1960s, uses radioactive tracers to visualize the circulation and volume of blood in the brain.
- Brain-imaging studies have provided new insights into sensory, motor, language, and memory processes, as well as brain disorders such as epilepsy; cerebra-vascular disease; Alzheimer's, Parkinson, and Huntington's diseases; and various mental disorders, such as schizophrenia.

Evolution of the Brain

Mammalian Brain

In mammals, as in other animals, intelligence is linked to the size and structure of the brain. The brains of mammals and other vertebrates are divided into three parts: the hindbrain, midbrain,

and forebrain. The hindbrain deals mainly with essential body processes, such as breathing, while the midbrain receives and coordinates sensory and motor impulses. The forebrain integrates and processes information, enabling an animal to make decisions and respond to the world around it. In mammals, the forebrain is highly developed and it has a folded surface that enables it to contain millions of interconnected neurons, or nerve cells.

Animals are guided by their senses, which provide feedback about their changing surroundings. In animals that have radial symmetry (symmetry around a central point), such as jellyfishes, sensory nerves are arranged more or less evenly around the body. This arrangement makes the animal equally sensitive to stimuli from any direction. In bilaterally symmetrical animals (animals made of equal halves); sensory nerves are concentrated in the head. They convey signals to the brain from organs such as ears and eyes, telling an animal about the surroundings that it is about to encounter.

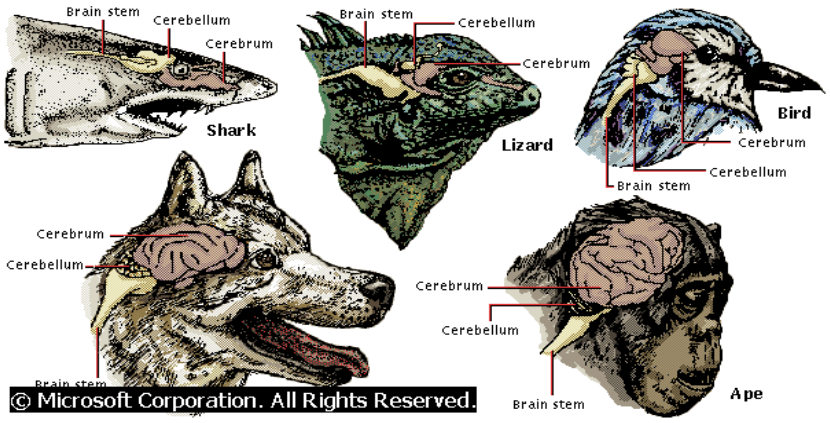
Reptilian Brain

Like all vertebrates, reptiles have a central nervous system and a well-developed brain. Most have two lungs, although many snakes have lost their left lungs over the course of evolution. All reptiles but crocodiles and their relatives have three-chambered hearts. In the crocodile group, the heart has four chambers, like the hearts of mammals and birds.

The reptile digestive system is much like that of other vertebrates, but in reptiles, the gut and the ducts of the urinary and sexual organs empty into a posterior chamber called the cloaca. In many reptiles, particularly those inhabiting hot, arid environments, wastes from the kidneys are passed to the cloaca, where water is absorbed back into the body for reuse. The remaining wastes leave the body through a muscular opening in the cloaca, located at the base of the tail.

Vertebrate Brains

Although all vertebrate brains share the same basic three-part structure, the development of their constituent parts varies across the evolutionary scale. In fish, the cerebrum is dwarfed by the rest of the brain and serves mostly to process input from the senses. In reptiles and amphibians, the cerebrum is proportionally larger and begins to connect and form conclusions about this input. Birds have well-developed optic lobes, making the cerebrum even larger. Among mammals, the cerebrum dominates the brain. It is most developed among primates, in whom cognitive ability is the highest.



In lower vertebrates, such as fish and reptiles, the brain is often tubular and bears a striking resemblance to the early embryonic stages of the brains of more highly evolved animals.

In all vertebrates, the brain is divided into three regions:

- The forebrain (pros-encephalon), the midbrain (mesencephalon), and the hindbrain (rhomb encephalon). These three regions further subdivide into different structures, systems, nuclei, and layers.
- The more highly evolved the animal, the more complex is the brain structure.
- Human beings have the most complex brains of all animals. Evolutionary forces have also resulted in a progressive increase in the size of the brain.
- In vertebrates lower than mammals, the brain is small. In meat-eating animals, particularly primates, the brain increases dramatically in size.
- The cerebrum and cerebellum of higher mammals are highly convoluted in order to fit the most gray matter surface within the confines of the cranium.
- Such highly convoluted brains are called gyrencephalic. Many lower mammals have a smooth, or lissencephalic “smooth head” cortical surface.
- There is also evidence of evolutionary adaption of the brain. For example, many birds depend on an advanced visual system to identify food at great distances while in flight.
  - Consequently, their optic lobes and cerebellum are well developed, giving them keen sight and outstanding motor coordination in flight.
- Rodents, on the other hand, as nocturnal animals, do not have a well-developed visual system.
  - Instead, they rely more heavily on other sensory systems, such as a highly developed sense of smell and facial whiskers.

Recent Research

Scientific understanding of the brain was dramatically changed in late 1998 when two independent discoveries revealed that brain cells can regenerate and that the fetal human brain contains master cells, known as neural stem cells, which can grow into any type of brain cell.

- Previously, scientists believed human brain cells could never regenerate themselves, although earlier studies of rodents, fish, reptiles, and birds had demonstrated that brain cell regeneration occurred in these animals.
- The new findings gave medical researchers hope that many brain disorders, such as Alzheimer's and Parkinson, could one day be cured, either by finding new drugs that encourage cell regeneration, or through brain cell transplants made possible by stem cell research.
- The Human Genome Project also helped shed new light on the brain. When it was completed in 2003, scientists realized that about half of the estimated 20,000 to 25,000 genes that make up human beings are devoted to the development, function, and structure of the brain.
- Medical researchers also continue to investigate the effect of stress on the human brain and its influence on the human immune system.
- For example, stressful events can activate the sympathetic division of the autonomic nervous system and divert blood from the internal organs and skin to the brain and muscles.

o The stress response also affects the hypothalamus and the pituitary gland, which regulate hormones, particularly the stress hormone cortisol. A better understanding of the brain-body connection may help medical researchers devise treatments for stress-related disorders.

- Finally, recent research in brain function suggests that there may be sexual differences in both brain anatomy and brain function.

o One study indicated that men and women may use their brains differently while thinking.
o Researchers used functional magnetic resonance imaging to observe which parts of the brain were activated as groups of men and women tried to determine whether sets of nonsense words rhymed.
o Men used only Broca's area in this task, whereas women used Broca's area plus an area on the right side of the brain.

Areas of Association

The areas of association, located mainly in the frontal cortex, operative in functions of thought and emotion and responsible for linking input from different senses. The areas of language are an exception: both Wernicke's area, concerned with the comprehension of spoken language, and Broca's area, governing the production of speech, have been pinpointed on the cortex.

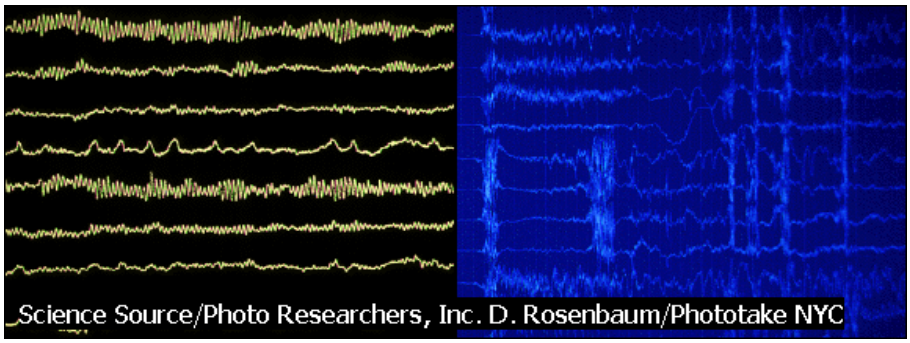
Memory Emotions

The thalamic pathway may be particularly useful in situations requiring a rapid response. Failing to respond to danger is more costly than responding inappropriately to a benign stimulus. For instance, the sound of rustling leaves is enough to alert us when we are walking in the woods without our having first to identify what is causing the sound.

Electroencephalography

Grand Mal Seizure EEG: The electroencephalograph (EEG) pattern of a normal individual, left, shows low amplitude tracings from each of the electrodes that have been placed on the head. In

an EEG pattern from an individual suffering from a grand mal seizure, right, these tracings exhibit both high amplitude and an erratic pattern lasting for several minutes.



Electroencephalography, procedure for obtaining a record of the electrical activity of the brain by means of electrodes attached to the surface of the skull. Normal patterns on the electroencephalogram, or EEG, include the alpha wave, indicative of a relaxed state, and the theta wave, usually found in children and thought by some to reflect creative activity in adults. Medically the most important use of electroencephalography is to aid in the diagnosis of epilepsy. The EEG tracing can identify a specific site at which damage to the brain has occurred. Study of EEGs has contributed to research into the nature of sleep, helping to identify four stages of sleep.

Scientists have also analyzed brain waves stimulated by sensory input, such as a flash of light or a sound, as a means of determining which parts of the brain carry out various functions. The finding of a flat or wave less, EEG in persons in coma has been interpreted as an absence of brain function and used as legal evidence of death.

Coma

Coma, in medicine, state of unconsciousness in which a person is unresponsive to external stimuli. In the deepest coma, spontaneous respiration ceases, and a mechanical respirator must be used. Coma may last for a few days or, in rare cases, for years, usually progressing after the first month to a persistent vegetative state. Coma in which electrical activity can no longer be detected in the brain is called brain-death syndrome

Mental Illness

A number of mental illnesses—such as depression, anxiety disorders, schizophrenia, and bipolar disorder—occur worldwide. Others seem to occur only in particular cultures. For example, eating disorders, such as anorexia nervosa (compulsive dieting associated with unrealistic fears of fatness), occur mostly among girls and women in Europe, North America, and Westernized areas of Asia, whose cultures view thinness as an essential component of female beauty.

In Latin America, people who experience overwhelming fright after a dangerous or traumatic event are said to have susto (fright), an illness in which their soul has been frightened away.

In some societies of West Africa and elsewhere, brain fag describes individuals (usually students) who experience difficulties in concentrating and thinking, as well as physical symptoms of pain and fatigue.

Brain Fog

The "brain fog" is a condition that can cause problems with work and personal relationships and even lead to accidents or delinquency. "Brain fog" isn't a medical term, but it describes a cluster of symptoms that most of us can relate to more readily than any textbook diagnosis. Whether frequent or occasional, that fogginess can interfere with our ability to think

Characteristics of brain fog can include difficulty concentrating or paying attention, feeling hazy, not remembering simple things, feeling mentally tired or drained, experiencing a lack of clarity, becoming abnormally confused, or feeling discouraged or a bit depressed.

High-stress situations, exceptionally long work hours, and excessive multitasking can all contribute to mental fogginess. Frequently, underlying hormonal imbalances are also to blame, and can heighten the negative effects of challenging situations.

Hormone imbalance causes Brain Fog: The Mind Health Report consulted Alicia Stanton, M.D., a doctor who is board certified in obstetrics and gynecology. Dr. Stanton specializes in helping both men and women find a healthy balance for their hormone levels; she also lectures on this subject to physicians throughout the United States and around the world. "Hormones are your body's messengers, taking signals from your brain to your cells, from your cells to your glands, and from your glands to your brain," says Dr. Stanton. "Unbalanced hormones act like a stoplight: The messages can't get through." Brain fog is one symptom of unbalanced hormones.

Low Thyroid and Brain Fog

Low levels of thyroid hormone are estimated to affect one in seven Americans, and brain fog is one of the most common symptoms. Others include: Constipation, Dry skin, Weight gain, Thinning of the outer part of the eyebrows, Lack of energy, Depression, Dry, coarse hair, Muscle cramps, Swelling of the legs, and Increased sensitivity to cold.

Lack of iodine in the diet is one reason for low thyroid levels, especially for anyone who doesn't eat regular table salt, which is iodized. Iodine is not usually added to sea salt or gourmet salts, which many people view as a healthier option. Other good food sources of iodine include the seaweed used in sushi rolls and other Asian, dishes, and kelp, which is used as a seasoning. To maintain healthy thyroid function, only a small amount of these foods is necessary. Eating sushi (a type that includes seaweed) once a week will fulfill your iodine needs. Dried seaweed is also available as a seasoned snack. Dr. Stanton does not recommend taking iodine supplements without a physician's supervision, as taking too much can put the thyroid into overdrive, causing

symptoms such as anxiety and hyperactivity. Two other minerals, selenium and zinc, are especially important for healthy thyroid function, and are best taken in a multivitamin.

Fit Heart Keeps the Brain Young

Keeping your heart healthy and strong may slow down the aging of your brain, according to a study of 1,504 people between the ages of 34 and 84. Researchers at Boston University School of Medicine have found a correlation between how much blood the heart pumps and the size of the brain, which naturally shrinks with age. Among study participants, only 7 percent had heart disease. However, about 30 percent had a low cardiac index, meaning that their hearts pumped lower than normal amounts of blood. Of that 30 percent, MRIs showed that subject's brains were smaller by an amount equivalent to two years of aging, compared to people with a high cardiac index. Brains were also smaller among people whose cardiac index was on the low end of normal. The people with smaller brains did not have impaired brain function, but researchers remained concerned that "the structural changes may be early evidence that something is wrong," according to lead researcher Angela L. Jefferson, Ph.D.

Currently, the brain-heart connection is not well understood. However, one theory speculates that "a lower volume of blood pumping from the heart might reduce blood flow to the brain, providing less oxygen and fewer nutrients needed for brain cells," said Jefferson. As a general rule, the ability of the heart to pump more blood with each beat increases with regular aerobic exercise. The heart becomes stronger when it is challenged to work harder during physical activity.

Other Hormonal Factors

Low levels of estrogen in women and testosterone in men are other factors that contribute to brain fog. For both genders, alcohol can lower levels of these hormones and should be consumed in limited amounts. In men, alcohol also contributes to testosterone being converted into estrogen. Zinc, on the other hand, supports healthy testosterone production for men. For women, B vitamins and indole-3-carbinol (a compound found in cruciferous vegetables such as broccoli) help estrogen to be metabolized in a way that reduces risk of estrogen-related cancers.

For everyone, toxins in food, water, grooming and beauty products, household cleaners and air fresheners, and garden pesticides disrupt hormones and can lead to brain fog. Non-toxic "green" products are a far safer alternative. In particular, it's wise to avoid products with "fragrances," which are typically synthetically made odors with hormone-disrupting compounds. Instead, look for products scented with essential oils, which are not hazardous.

Changes in the course of life, such as "menopause" or male "andropause" are natural periods of hormonal transition. However, when combined with stress-inducing diets and life situations, along with environmental toxins, shifting hormone levels are likely to prompt brain fog and other unpleasant symptoms. Where diet, exercise, stress reduction, and nutritional supplements do not

resolve a situation, a physician trained in balancing hormones can help by testing and prescribing appropriate and safe hormone-balancing treatment.

Blocking Memory/Tip of the Tongue State

Another curious phenomenon is the tip-of-the-tongue state. This term refers to the situation in which a person tries to retrieve a relatively familiar word, name, or fact, but cannot quite do so. Although the missing item seems almost within grasp, its retrieval eludes the person for some time. The feeling has been described as like being on the brink of a sneeze. Most people regard the tip-of-the-tongue state as mildly unpleasant and its eventual resolution, if and when it comes, as a relief. Studies have shown that older adults are more prone to the tip-of-the-tongue phenomenon than are younger adults, although people of all ages report the experience.

Paul Broca

Damage to Broca's area in the frontal lobe causes difficulty in speaking and writing, a problem known as Broca's aphasia. Injury to Wernicke's area in the left temporal lobe results in an inability to comprehend spoken language, called Wernicke's aphasia.

Part II - Contributions of Great Philosophers to Artificial Intelligence

Executive Summary of Saint Thomas Aquinas

13th century: Saint Thomas Aquinas sought to reconcile Aristotelian philosophy with Augustinian theology. Aquinas employed both reason and faith in the study of metaphysics, moral philosophy, and religion. While Aquinas accepted the existence of God on faith, he offered five proofs of God's existence to support such a belief.

Saint Thomas Aquinas, sometimes called the Angelic Doctor and the Prince of Scholastics (1225-1274), Italian philosopher and theologian, works have made him the most important figure in Scholastic philosophy and one of the leading Roman Catholic theologians.

1248: Because Aquinas was heavyset and taciturn, his fellow novices called him Dumb Ox, but Albertus Magnus is said to have predicted that "this ox will one day fill the world with his bellowing." Returning to Paris in 1268, Aquinas immediately became involved in a controversy with the French philosopher Siger de Brabant and other followers of the Islamic philosopher Averroës.

Before the time of Aquinas, Western thought had been dominated by the philosophy of Saint Augustine, the Western church's great Father and Doctor of the 4th and 5th centuries, who taught that in the search for truth people must depend upon sense experience.

Early 13th century: The major works of Aristotle were made available in a Latin translation, accompanied by the commentaries of Averroës and other Islamic scholars. The vigor, clarity,

and authority of Aristotle's teachings restored confidence in empirical knowledge and gave rise to a school of philosophers known as Averroists. Under the leadership of Siger de Brabant, the Averroists asserted that philosophy was independent of revelation.

Averroism threatened the integrity and supremacy of Roman Catholic doctrine and filled orthodox thinkers with alarm. To ignore Aristotle, as interpreted by the Averroists, was impossible; to condemn his teachings was ineffectual. He had to be reckoned with. Albertus Magnus and other scholars had attempted to deal with Averroism, but with little success. Aquinas succeeded brilliantly. Reconciling the Augustinian emphasis upon the human spiritual principle with the Averroist claim of autonomy for knowledge derived from the senses, Aquinas insisted that the truths of faith and those of sense experience, as presented by Aristotle, are fully compatible and complementary.

Mystery of Incarnation

Some truths, such as that of the mystery of the incarnation, can be known only through revelation, and others, such as that of the composition of material things, only through experience; still others, such as that of the existence of God, are known through both equally. All knowledge Aquinas held, originates in sensation, but sense data can be made intelligible only by the action of the intellect, which elevates thought toward the apprehension of such immaterial realities as the human soul, the angels, and God.

To reach understanding of the highest truths, those with which religion is concerned, the aid of revelation is needed. Aquinas's moderate realism placed the universals firmly in the mind, in opposition to extreme realism, which posited their independence of human thought. He admitted a foundation for universals in existing things, however, in opposition to nominalism and conceptualism.

1272: Aquinas left Paris and proceeded to Naples, where he organized a new Dominican school.

1274: While traveling to the Council of Lyon, to which he had been commissioned by Pope Gregory X, Aquinas fell ill. He died on March 7 at the Cistercian monastery of Fossanova.

1323: Aquinas was canonized by Pope John XXII.

1567: Aquinas was proclaimed a Doctor of the Church by Pope Pius V.

Aquinas organized the knowledge of his time in the service of his faith. In his effort to reconcile faith with intellect, he created a philosophical synthesis of the works and teachings of Aristotle and other classic sages of Augustine and other church fathers, of Averroës, Avicenna, and other Islamic scholars, of Jewish thinkers such as Maimonides and Solomon ben Yehuda ibn Gabirol, and of his predecessors in the Scholastic tradition. This synthesis he brought into line with the Bible and Roman Catholic doctrine.

Aquinas's accomplishment was immense; his work marks one of the few great culminations in the history of philosophy. After Aquinas, Western philosophers could choose only between humbly following him and striking off in some altogether different direction. In the centuries immediately following his death, the dominant tendency, even among Roman Catholic thinkers, was to adopt the second alternative. Interest in Thomist philosophy began to revive, however, toward the end of the 19th century.

In the encyclical *Aeterni Patris* (Of the Eternal Father, 1879), Pope Leo XIII recommended that St. Thomas's philosophy be made the basis of instruction in all Roman Catholic schools.

Pope Pius XII, in the encyclical *Humani Generis* (Of the Human Race, 1950), affirmed that the Thomist philosophy is the surest guide to Roman Catholic doctrine and discouraged all departures from it.

Thomism remains a leading school of contemporary thought. Among the thinkers, Roman Catholic and non-Roman Catholic alike, who have operated within the Thomist framework have been the French philosophers Jacques Maritain and Étienne Gilson.
St. Thomas was an extremely prolific author, and about 80 works are ascribed to him.

The two most important are *Summa Contra Gentiles* (1261-1264) and *Summa Theologica* (1265-1273). *Summa Contra Gentiles,* which has been translated into English as *On the Truth of the Catholic Faith* (1956), is a closely reasoned treatise intended to persuade intellectual Muslims of the truth of Christianity.

Summa Theologica, which has been republished frequently in Latin and vernacular editions under its Latin title, was written in three parts (on God, on the moral life, and on Christ) and was intended to set forth Christian doctrine for beginners. The last part remained unfinished at his death.

In 1614, John Napier invented logarithms, which allow the multiplication of two numbers by adding their exponents. John Napier of Scotland introduced two ways of handling multiplication in terms of addition. Napier bones: It was the first pocket calculator. Napier's bones was a set of ivory sticks marked with numbers that could be used to multiply merely by adding.

Executive Summary of Thomas Hobbes

Thomas Hobbes, English political philosopher, English philosopher and political theorist. Thomas Hobbes is best known for his treatise *Leviathan.* Written during the mid-17th century amidst the tumult of the English Revolution, *Leviathan* outlines Hobbes's theory of sovereignty (political authority).

Thomas Hobbes, one of the first modern Western thinkers to provide a secular justification for the political state. The philosophy of Hobbes marked a departure in English philosophy from the religious emphasis of Scholasticism. His ideas represented a reaction against the

decentralizing ideas of the Reformation (1517-1648) which, Hobbes contended, brought anarchy. Regarded as an important early influence on the philosophical doctrine of utilitarianism, Hobbes also contributed to modern psychology and laid the foundations of modern sociology by applying mechanistic principles in an attempt to explain human motivation and social organization.

Hobbes returned to England in 1637 and published his *Little Treatise,* which outlined his new theory of motion. Interrupted by the constitutional struggle between King Charles I and Parliament, Hobbes set to work on defense of the royal prerogative.

This work was privately circulated in 1640 under the title *The Elements of Law, Natural and Politic* and was published in 1650. Hobbes, fearing that Parliament might have him arrested because of his book, fled to Paris, where he remained in voluntary exile for 11 years.

1642: Hobbes finished *De Cive,* (On Citizenship; translated in 1651), a statement of his theory of government.

1646 to 1648: He was mathematics tutor to the Prince of Wales, later King Charles II, who was living in exile in Paris. Hobbes's best-known work, *Leviathan; or, The Matter, Form, and Power of a Commonwealth Ecclesiastical and Civil* (1651), is a forceful exposition of his doctrine of sovereignty.

The work was interpreted by the followers of the exiled prince as a justification of the Commonwealth and aroused the suspicions of the French authorities by its attack on the papacy. Again fearful of arrest, Hobbes returned to England.

1660: When the Commonwealth ended and his former pupil (Prince of Wales, King Charles II acceded to the throne, Hobbes again came into favor.

1666: The House of Commons passed a bill including *Leviathan* among the books to be investigated on charges of atheistic tendencies (Hobbes argued for a distinction between knowledge and faith and suggested that one could not gain a knowledge of God).

The measure caused Hobbes to burn many of his papers and to delay publication of three of his works: *Behemoth: The History of the Causes of Civil Wars of England; Dialogues Between a Philosopher and a Student of the Common Laws of England;* and a metrical *Historia Ecclesiastica.* At the age of 84, Hobbes wrote an autobiography in Latin verse. Within the next three years he translated into English verse the *Iliad* and the *Odyssey* of Homer. He died at the age of 91.

Three previously unattributed essays of Hobbes were published. These writings suggest the influence of Italian political theorist Niccolò Machiavelli on Hobbes's ethics and politics. Developing his politics and ethics from a naturalistic basis of self-interest. Hobbes held that since people are fearful and predatory they must submit to the absolute supremacy of the state, in

both secular and religious matters, in order to live by reason and gain lasting preservation. Within psychology, he proposed that all human actions are caused by material phenomena, with people motivated by what he termed *appetite* (movement toward an object; similar to pleasure) or *aversion* (movement away from an object; similar to pain).

Executive Summary of John Locke

John Locke (1632-1704), English philosopher, founded the school of empiricism. A school of philosophy that was based on the belief that knowledge comes from everyday experience, scientific observation, and common sense, rather than from the application of reason alone. Locke's *Essay Concerning Human Understanding* (1690) portrays each individual as a blank slate. The person's experiences become notations on the slate and make each individual distinct from other people.

1669: Locke wrote a constitution for the proprietors of the Carolina Colony in North America, but it was never put into effect.

1675: After the liberal Shaftesbury had fallen from favor, Locke went to France.

1679: He returned to England, but in view of his opposition to the Roman Catholicism favored by the English monarchy at that time, he soon found it expedient to return to the Continent.

1683-1690: Locke lived in Holland, and following the so-called Glorious Revolution of 1688 and the restoration of Protestantism to favor, Locke returned once more to England. Locke's views, in his *Two Treatises of Government* (1690), attacked the theory of divine right of kings and the nature of the state as conceived by English philosopher and political theorist Thomas Hobbes. Locke argued that sovereignty did not reside in the state but with the people, and that the state is supreme, but only if it is bound by civil and what he called "natural" law. Many of Locke's political ideas, such as those relating to natural rights, property rights, the duty of the government to protect these rights, and the rule of the majority, were later embodied in the Constitution of the United States.

Locke further held that revolution was not only a right but often an obligation, and he advocated a system of checks and balances in government. He also believed in freedom of religion and in the separation of church and state. Locke's influence in modern philosophy has been profound and, with his application of empirical analysis to ethics, politics, and religion. He remains one of the most important and controversial philosophers of all time. Among his other works are *Some Thoughts Concerning Education* (1693) and *The Reasonableness of Christianity* (1695).

1696: The new king, William III, appointed Locke to the Board of Trade in 1696, a position from which he resigned because of ill health in 1700.

1704: John Locke died.

Locke's empiricism emphasizes the importance of the experience of the senses in pursuit of knowledge rather than intuitive speculation or deduction. The empiricist doctrine was first expounded by English philosopher and statesman Francis Bacon early in the 17th century, but Locke gave it systematic expression in his *Essay Concerning Human Understanding* (1690). He regarded the mind of a person at birth as a *tabula rasa,* a blank slate upon which experience imprinted knowledge, and did not believe in intuition or theories of innate conceptions. Locke also held that all persons are born good, independent and equal.

Executive Summary of Voltaire

1700's: The French writer and philosopher Voltaire is considered one of the central figures of the Age of Enlightenment of this period, a period which emphasized the power of human reason, science, and respect for humanity. Voltaire believed that literature should serve as a vehicle for social change. His biting satires and philosophical writings demonstrated his aversion to Christianity, intolerance, and tyranny.

1718: The expression captured in this portrait of Voltaire in 1718 hints at the sharp sense of humor with which he won the favor of 18th-century French society.

Voltaire, assumed name of François Marie Arouet (1694-1778), French writer and philosopher, who was one of the leaders of the Enlightenment. Voltaire quickly chose literature as a career. He began moving in aristocratic circles and soon became known in Paris salons as a brilliant and sarcastic wit.

Bastille Incarceration

A number of his writings, particularly a lampoon accusing the French regent Philippe II, duc d'Orléans of heinous crimes, resulted in his imprisonment in the Bastille. During his 11-month detention, Voltaire completed his first tragedy, *Œdipe*, which was based upon the *Œdipus tyrannus* of the ancient Greek dramatist Sophocles, and commenced an epic poem on Henry IV of France.

1718: *Œdipe* was given its initial performance at the Théâtre-Français in 1718 and received with great enthusiasm.

1723: The work on Henry IV was printed anonymously in Geneva under the title of *Poème de la ligue* (Poem of the League, 1723). In his first philosophical poem, *Le pour et le contre* (For and Against), Voltaire gave eloquent expression to both his anti-Christian views and his rationalist, deist creed.

A quarrel with a member of an illustrious French family, the chevalier de Rohan, resulted in Voltaire's second incarceration in the Bastille, from which he was released within two weeks on his promise to quit France and proceed to England. Accordingly he spent about two years in London. Voltaire soon mastered the English language, and in order to prepare the British public

for an enlarged edition of his *Poème de la ligue,* he wrote in English two remarkable essays, one on epic poetry and the other on the history of civil wars in France. For a few years the Catholic, autocratic French government prevented the publication of the enlarged edition of *Poème de la ligue*, which was retittled *La Henriade* (The Henriad).

1728: The government finally allowed the poem to be published. This work, an eloquent defense of religious toleration, achieved an almost unprecedented success, not only in Voltaire's native France but throughout all of the continent of Europe as well.

Sculpture of Voltaire

French sculptor Jean-Antoine Houdon was well known for his portraits in stone. Highly regarded in the United States as well as in Europe, Houdon created the only statue for which George Washington posed. This statue of French Enlightenment writer and philosopher Voltaire stands in the Comédie Française theater in Paris, where Voltaire's plays are still performed.

Voltaire returned to France in 1728. During the next four years he resided in Paris and devoted most of his time to literary composition. The chief work of this period is the *Lettres philosophiques* (The Philosophical Letters, 1734). A covert attack upon the political and ecclesiastical institutions of France, this work brought Voltaire into conflict with the authorities, and he was once more forced to quit Paris.

He found refuge at the Château de Cirey in the independent duchy of Lorraine. There he formed an intimate relationship with the aristocratic and learned Gabrielle Émilie Le Tonnelier de Breteuil, marquise du Châtelet, who exerted a strong intellectual influence upon him.

Voltaire's sojourn at Cirey in companionship with the marquise du Châtelet was a period of intense literary activity. In addition to an imposing number of plays, he wrote the *Élements de la philosophie de Newton* (Elements of the Philosophy of Newton), and produced novels, tales, satires, and light verses. Voltaire's stay at Cirey was not without interruptions. He often traveled to Paris and to Versailles, where, through the influence of the marquise de Pompadour, the famous mistress of Louis XV, he became a court favorite.

1745-46: His *Poème de Fontenoy* (1745), describing a battle won by the French over the English during the War of the Austrian Succession, and his *Précis du siècle de Louis XV* (Epitome of the Age of Louis XV), in addition to his dramas *La princesse de Navarre* and *Le triomphe de Trajan,* were the outcome of Voltaire's connection with the court of Louis XV. He was first appointed historiographer of France, and then a gentleman of the king's bedchamber; finally, in 1746, he was elected to the French Academy.

1749-50: Following the death of Madame du Châtelet in 1749, Voltaire finally accepted a long-standing invitation from Frederick II of Prussia to become a permanent resident at the Prussian court. He journeyed to Berlin in 1750 but did not remain there more than two years, because his acidulous wit clashed with the king's autocratic temper and led to frequent disputes. While at

Berlin he completed his *Siècle de Louis XIV,* a historical study of the period of Louis XIV (1638-1715).

Attack on Religion

1758: For some years Voltaire led a migratory existence, but he finally settled in 1758 at Ferney, where he spent the remaining 20 years of his life. In the interval between his return from Berlin and his establishment at Ferney, he completed his most ambitious work, the *Essai sur l'histoire générale et sur les moeurs et l'esprit des nations* (Essay on General History and on the Customs and the Character of Nations, 1756).

In this work, a study of human progress, Voltaire decries supernaturalism and denounces religion and the power of the clergy, although he makes evident his own belief in the existence of God. Feeling secure in his sequestered retreat, he sent forth hundreds of short squibs and broadsides satirizing abuses that he desired to expose.

Those who suffered persecution because of their beliefs found in Voltaire an eloquent and powerful defender. The flavor of Voltaire's activities could be summarized in the phrase he often used: *écrasons l'infâme* ("let us crush the infamous one"). With this phrase, he referred to any form of religion that persecutes non-adherents or that constitutes fanaticism. For Christianity he would substitute deism, a purely rational religion. *Candide,* in which Voltaire analyzes the problem of evil in the world, depicts the woes heaped upon the world in the name of religion.

May 30, 1778: Voltaire died. Voltaire's contradictions of character are reflected in his writings as well as in the impressions of others. He seemed able to defend either side in any debate, and to some of his contemporaries he appeared distrustful, avaricious and sardonic; others considered him generous, enthusiastic, and sentimental. Essentially, he rejected everything irrational and incomprehensible and called upon his contemporaries to act against intolerance, tyranny, and superstition.

His morality was founded on a belief in freedom of thought and respect for all individuals, and he maintained that literature should be useful and concerned with the problems of the day. These views made Voltaire a central figure in the 18th-century philosophical movement typified by the writers of the famous French *Encyclopédie.* Because he pleaded for a socially involved type of literature, Voltaire is considered a forerunner of such 20th-century writers as Jean-Paul Sartre and other French existentialists. All of Voltaire's works contain memorable passages distinguished by elegance, perspicuity, and wit. His poetic and dramatic works, however, are marred often by too great a concentration on historical matter and philosophical propaganda.

Deism

17^{th}-18^{th} Century: Deism, a rationalist religious philosophy that flourished during these centuries, particularly in England. It is a belief in God based on reason rather than revelation and

involving the view that God has set the universe in motion but does not interfere with how it runs.

Generally, Deists held that a certain kind of religious knowledge (sometimes called natural religion) is either inherent in each person or accessible through the exercise of reason, but they denied the validity of religious claims based on revelation or on the specific teachings of any church. Deism emerged as a major religious and philosophical view in England.

The most prominent Deists were Edward Herbert, John Toland, and Charles Blount, all of whom advocated a rationalist religion and criticized the supernatural or nonrational elements in the Jewish and Christian traditions.

Anthony Collins, Thomas Chubb, and Matthew Tindal sharpened the rationalist attack on orthodoxy by attempting to discredit the miracles and mysteries of the Bible. Although these challenges to traditional and orthodox interpretations of Christianity aroused much opposition, the Deists did much to establish the intellectual climate of Europe in the 18th century. Their emphasis on reason and their opposition to fanaticism and intolerance greatly influenced the English philosophers John Locke and David Hume.

In France, the philosopher Voltaire became a particularly effective proponent of Deism and intensified his predecessors' rationalist critique of Scripture. Nonetheless, he retained the English Deists' view that a deity certainly exists. Versions of Deism, some of them approaching atheism, were advocated by many other prominent figures of the European Enlightenment.

Deism was also influential in late-18th-century America, where Deistic views were held by Benjamin Franklin, Thomas Jefferson, and George Washington. The most vociferous Deists in America were Ethan Allen and Thomas Paine. Deism in Europe and America played an important role both in exposing traditional religion to rationalist criticism and in encouraging the development of rationalist philosophy. Elements of the Deists' ideas have been absorbed by Unitarianism, Modernism, and other modern religious tendencies.

Contributed By: Richard H. Popkin

Executive Summary of David Hume

David Hume (1711-1776), Scottish historian and philosopher, Microsoft ® Encarta ® 2007. © 1993-2006 Microsoft Corporation. All rights reserved.

David Hume influenced the development of skepticism and empiricism, two schools of philosophy. A Scottish philosopher, he is considered one of the greatest skeptics in the history of philosophy. Hume thought that one can know nothing outside of experience, and experience—based on one’s subjective perceptions never provides true knowledge of reality.

Even the law of cause and effect was, for Hume, an unjustified belief: If one drops a ball, one cannot be certain it will fall to the ground. Rather, it is only possible to recognize through past experience that certain pairs of events (dropping a ball, the ball striking the ground) have always accompanied one another. Hume was educated at home and at the University of Edinburgh, at which he matriculated at the age of 12.

1734 to 1765: Hume occupied himself intensively with the problems of speculative philosophy and during this period wrote his most important philosophical work. *A Treatise of Human Nature* (3 volumes, 1739-40), embodies the essence of his thinking. In spite of its importance, this work was ignored by the public and was, as Hume himself said, "dead-born," probably because of its abstruse style. Hume's later works were written in the lighter essay or dialogue forms that were popular in his day. Early in his career, he was regarded as a religious skeptic.

Hume became, successively, tutorer to the insane marquis of Annandale and judge advocate to a British military expedition to France. During his 12-year stay in Edinburgh, Hume worked chiefly on his six-volume *History of England*, which appeared at intervals. Hume served as secretary to the British ambassador in Paris. There he was lionized by French literary circles and formed a friendship with the French philosopher Jean Jacques Rousseau. Hume brought Rousseau back with him to England. Rousseau, however, plagued by delusions of persecution, accused Hume of plotting against him, and the friendship dissolved in public denunciations between the two men.

Hume had written the *Dialogues* in the early 1750s but had withheld the work because of its skepticism. His philosophical position was influenced by the ideas of the British philosophers John Locke and Bishop George Berkeley. Hume and Berkeley both differentiated between reason and sensation. Hume, however, went further, endeavoring to prove that reason and rational judgments are merely habitual associations of distinct sensations or experiences.

Hume rejected the basic idea of causation, maintaining that "reason can never show us the connection of one object with another, tho' aided by experience, and the observation of their conjunction in all past instances. When the mind, therefore, passes from the idea or impression of one object to the idea or belief of another, it is not determined by reason, but by certain principles, which associate together the ideas of these objects and unite them in the imagination."

Hume's rejection of causation implies a rejection of scientific laws, which are based on the general premise that one event necessarily causes another and predictably always will. According to Hume's philosophy, therefore, knowledge of matters of fact is impossible, although as a practical matter he freely acknowledged that people had to think in terms of cause and effect, and had to assume the validity of their perceptions, or they would go mad.

He also admitted the possibility of knowledge of the relationships among ideas, such as the relationships of numbers in mathematics. Hume's skeptical approach also denied the existence both of the spiritual substance postulated by Berkeley and of Locke's "material substance." Going further, Hume denied the existence of the individual self, maintaining that because people

do not have a constant perception of themselves as distinct entities, they “are nothing but a bundle or collection of different perceptions.”

Ethical Thinking

Hume held that the concept of right and wrong is not rational but arises from a regard for one's own happiness. The supreme moral good, according to his view, is benevolence, an unselfish regard for the general welfare of society that Hume regarded as consistent with individual happiness. As a historian Hume broke away from the traditional chronological account of wars and deeds of state and attempted to describe the economic and intellectual forces that played a part in the history of his country.

Hume's contributions to economic theory, which influenced the Scottish philosopher and economist Adam Smith and later economists, included his belief that wealth depends not on money but on commodities and his recognition of the effect of social conditions on economics.

Executive Summary of Immanuel Kant

Immanuel Kant (1724-1804), German Philosopher, Microsoft ® Encarta ® 2007. © 1993-2006 Microsoft Corporation. All rights reserved.

He is considered by many the most influential thinker of modern times. Eighteenth-century German philosopher Immanuel Kant explored the possibilities of what reason can tell about the world of experience. In his critiques of science, morality, and art, Kant attempted to derive universal rules to which, he claimed, every rational person should subscribe.

In *Critique of Pure Reason* (1781), Kant argued that people cannot understand the nature of the things in the universe, but they can be rationally certain of what they experience themselves. Within this realm of experience, fundamental notions such as space and time are certain. Kant did not receive a chair at the university until 1770, when he was made professor of logic and metaphysics. For the next 27 years he continued to teach and attracted large numbers of students to Königsberg.

Kant's unorthodox religious teachings, which were based on rationalism rather than revelation, brought him into conflict with the government of Prussia, and in 1792 he was forbidden by Frederick William II, king of Prussia to teach or write on religious subjects. Kant obeyed this order for five years until the death of the king and then felt released from his obligation.

Critique of Pure Reason (1781) Revelations:

Kant examined the base of human knowledge and created an individual epistemology. Like earlier philosophers, Kant differentiated modes of thinking into analytic and synthetic propositions.

- An analytic proposition is one in which the predicate is contained in the subject, as in the statement “Black houses are houses.” The truth of this type of proposition is evident, because to state the reverse would be to make the proposition self-contradictory. Such propositions are called analytic because truth is discovered by the analysis of the concept itself.
- Synthetic propositions, on the other hand, are those that cannot be arrived at by pure analysis, as in the statement “The house is black.” All the common propositions that result from experience of the world are synthetic.

Propositions, according to Kant, can also be divided into two other types: empirical and a priori. Empirical propositions depend entirely on sense perception, but a priori propositions have a fundamental validity and are not based on such perception. The difference between these two types of proposition may be illustrated by the empirical “The house is black” and the a priori “Two plus two makes four.”

Kant's thesis in the *Critique* is that it is possible to make synthetic a priori judgments. This philosophical position is usually known as transcendentalism. In describing how this type of judgment is possible Kant regarded the objects of the material world as fundamentally unknowable; from the point of view of reason, they serve merely as the raw material from which sensations are formed. Objects of themselves have no existence, and space and time exist only as part of the mind, as “intuitions” by which perceptions are measured and judged.

Kant described his ethical system, which is based on a belief that the reason is the final authority for morality. Actions of any sort, he believed, must be undertaken from a sense of duty dictated by reason, and no action performed for expediency or solely in obedience to law or custom can be regarded as moral.

Kant described two types of commands given by reason: The hypothetical imperative, which dictates a given course of action to reach a specific end; and the categorical imperative, which dictates a course of action that must be followed because of its rightness and necessity.

The categorical imperative is the basis of morality and was stated by Kant in these words: “Act as if the maxim of your action were to become through your will a general natural law.” He believed that the welfare of each individual should properly be regarded as an end in itself. Kant advocated the establishment of a world federation of republican states.

Kant had a greater influence than any other philosopher of modern times. Kantian philosophy, particularly as developed by the German philosopher Georg Wilhelm Friedrich Hegel, was the basis on which the structure of Marxism was built. Hegel's dialectical method, which was used by Karl Marx, was an outgrowth of the method of reasoning by “antinomies” that Kant used.

Kant wrote a number of treatises on various scientific subjects, many in the field of physical geography. His most important scientific work was *General Natural History and Theory of the*

Heavens (1755), in which he advanced the hypothesis of the formation of the universe from a spinning nebula, a hypothesis that later was developed independently by Pierre de Laplace.

Executive Summary of John Stuart Mill

John Stuart Mill (1806-1873), British Philosopher-Economist, Microsoft ® Encarta ® 2007. © 1993-2006 Microsoft Corporation. All rights reserved.

19th-century British thought, not only in philosophy and economics but also in the areas of political science, logic, and ethics. Mill stands as a bridge between the 18th-century concern for liberty, reason, and science and the 19th-century trend toward empiricism and collectivism.

Mill advocated those policies that he believed most consistent with individual liberty, and he emphasized that liberty could be threatened as much by social as by political tyranny. He studied pre-Marxian socialist doctrine, and, although he did not become a socialist, he worked actively for improvement of the conditions of the working people. In Parliament, Mill was considered a radical, because he supported such measures as public ownership of natural resources, equality for women, compulsory education, and birth control. His advocacy of women's suffrage in the debates on the Reform Bill of 1867 led to the formation of the suffrage movement.

Executive Summary of George Berkeley

George Berkeley (1685-1753), Irish Philosopher and Clergyman, Microsoft ® Encarta ® 2007. © 1993-2006 Microsoft Corporation. All rights reserved.

Berkeley is regarded as the founder of the modern school of idealism, the philosophical view that all physical objects are dependent on the mind for their existence. He held that matter cannot be conceived to exist independent of the mind; the phenomena of sense can be explained only by supposing a deity that continually evokes perception in the human mind. According to Berkeley's early 18th-century writings, an object such as a table exists only if a mind perceives it. Hence, objects are ideas. When it failed to convince people of his theory, he published a more popular version. Both statements of his philosophy were regarded as foolish by his contemporaries.

1728: He went to America to attempt to found a missionary college in Bermuda. Although he abandoned his plan in 1732, Berkeley had a great effect on higher education while in America, assisting in the development of Yale and Columbia universities and a number of other schools. Berkeley's philosophical theory was developed as an answer to skepticism and atheism. He claimed that skepticism arises when experience or sensations are separated from things. Once this has been done, no way of knowing about things is possible except through ideas.

To overcome this separation, a person must recognize that the “being” of sensible things consists in their being perceived. Whatever is perceived is real, and the only things that can be known to exist are those that are perceived. Berkeley insisted, however, that things exist apart from the

human mind and perception, as people cannot control what ideas they have. Therefore, there must be a mind in which all the ideas exist, an infinite omnipresent spirit, namely, God, that perceives everything. Berkeley's philosophical system eliminated any possibility of knowledge of an external material world. Although his own system produced few followers, his criticisms of arguments for a separate external world and of the concept of matter were forceful and have influenced philosophers ever since.

Executive Summary of Bertrand Russell

Bertrand Russell (1872-1970), British Philosopher, Mathematician, and Nobel Laureate, Microsoft ® Encarta ® 2007. © 1993-2006 Microsoft Corporation. All rights reserved.

Russell's emphasis on logical analysis influenced the course of 20th-century philosophy. Bertrand Russell, along with British mathematician and philosopher Alfred North Whitehead, attempted to demonstrate that mathematics and numbers can be understood as groups of concepts, or classes. Russell and Whitehead tried to show that mathematics is closely related to logic and, in turn, that ordinary sentences can be logically analyzed using mathematical symbols for words and phrases.

This idea resulted in a new symbolic language, used by Russell in a field he termed philosophical logic, in which philosophical propositions were reformulated and examined according to his symbolic logic. He achieved prominence with his first major work, *The Principles of Mathematics* (1902), in which he attempted to remove mathematics from the realm of abstract philosophical notions and to give it a precise scientific framework.

Alfred North Whitehead produced the monumental work *Principia Mathematica* (3 volumes, 1910-1913). This work showed that mathematics can be stated in terms of the concepts of general logic, such as class and membership in a class. It became a masterpiece of rational thought. Russell borrowed from the fields of sociology, psychology, physics, and mathematics to refute the tenets of idealism, the dominant philosophical school of the period, which held that all objects and experiences are the product of the intellect.

Russell, a realist, believed that objects perceived by the senses have an inherent reality independent of the mind. He condemned both sides in World War I (1914-1918), and for his uncompromising stand he was fined, imprisoned, and deprived of his teaching post at Cambridge. He felt that the methods used to achieve a Communist system were intolerable and that the results obtained were not worth the price paid.

He was barred, however, from teaching at the College of the City of New York (now City College of the City University of New York) by the state supreme court because of his attacks on religion in such works as *What I Believe* (1925) and his advocacy of sexual freedom, expressed in *Marriage and Morals* (1929). He became an ardent and active opponent of nuclear weapons.

1949: Russell was awarded the Order of Merit by King George VI. He received the 1950 Nobel Prize for Literature and was cited as "the champion of humanity and freedom of thought." He led a movement in the late 1950s advocating unilateral nuclear disarmament by Britain, and at the age of 89 he was imprisoned after an antinuclear demonstration. Russell also made a major contribution to the development of logical positivism, a strong philosophical movement of the 1930s and 1940s.

Executive Summary-Scientists Contributions to Artificial Intelligence
Arnauld, Antoine, the most famous French exponent of Jansenism, Microsoft® Encarta® 2007.

17th- and 18th-century Roman Catholic theological movement of rigorous and unorthodox tendencies. A basic exposition of Jansenism principles was published. The work antagonized the Jesuits, with whom Arnauld engaged in bitter controversy for the remainder of his life. The Jesuits succeeded in bringing about his expulsion from the Sorbonne in 1656 and, despite the protection of Louis XIV of France, forced him into exile in Belgium in 1679. Undaunted, Arnauld continued to issue a barrage of polemical writings against numerous adversaries, including freethinkers and the Calvinists.

Averroës, Abu al-Walid Muhammad, Spanish-Arab Islamic Philosopher, Jurist, and Physician, Microsoft® Encarta® 2007.

Averroes's view that reason takes precedence over religion led to his being exiled in 1195. Averroës held that metaphysical truths can be expressed in two ways: through philosophy, as represented by the views of Aristotle, and through religion, which is truth presented in a form that the ordinary person can understand. He rejected the concept of a creation of the world in the history of time; the world, he maintained, has no beginning.

Babbage Charles, British mathematician and inventor, Microsoft® Encarta® 2007.

Babbage designed and built mechanical computing machines on principles that anticipated the modern electronic computer.

1820-54: Babbage began developing his Difference Engine, a mechanical device that can perform simple mathematical calculations. Babbage started to build his Difference Engine, but was unable to complete it because of a lack of funding.

Babbage began developing his Analytical Engine, which was designed to carry out more complicated calculations, but this device was never built. Babbage's book Economy of Machines and Manufactures (1832) initiated the field of study known today as operational research.

Boole described an algebraic system that later became known as Boolean algebra. In Boolean algebra, logical propositions are denoted by symbols and can be acted on by abstract mathematical operators that correspond to the laws of logic.

Binet, Alfred, French Psychologist, Microsoft® Encarta® 2007. © 1993-2006 Microsoft Corporation. All rights reserved.

Known for his achievement in developing a standard intelligence test. Binet helped to found the first psychological research laboratory in France. As director of the laboratory, Binet attempted to develop experimental techniques to measure intelligence and reasoning ability.

Binet's most important work was in intelligence test. With his colleague, psychologist Theodore Simon, he devised a test to measure the mental ability of children. The Binet-Simon Scale first appeared in 1905. It was made up of problems designed to measure general intelligence, and items were graded according to age level. His pioneering work on intelligence measurement remained influential among psychologists in other countries. In the United States, great importance was attached to intelligence testing, and the Stanford-Binet Scale, an adaptation of Binet's original test, was widely used for many years.

Breazeal, Cynthia Lynn (Ferrell) Breazeal is an American Scientist and Robotic expert, Microsoft® Encarta® 2007. © 1993-2006 Microsoft Corporation. All rights reserved.

She is best known for her work in human-computer interaction. Cynthia Breazeal has developed the robot Kismet as a doctoral research project looking into expressive social exchange between humans and humanoid robots. Now you can see Kismet in a museum which she has decided to put up for all of her past creations. Breazeal has also developed, planetary micro-rovers, upper-torso humanoid robots, expressive robotic faces, and plant-like robots.

Brentano, Franz, German/Australian Philosopher and Psychologist, Microsoft® Encarta® 2007. © 1993-2006 Microsoft Corporation. All rights reserved.

Brentano claimed that “the true method of philosophy is none other than that of the natural sciences.” Brentano introduced the notion of the “intentionality” of mental phenomena into modern philosophical discourse. This idea led the way for the preoccupation in 20th-century philosophy with the nature of such intentional phenomena as meaning, cognition, perceiving, referring, and intending.

Brentano’s vision of a scientific philosophy exerted tremendous influence on later German philosophers, such as Alexius Meinong, Edmund Husserl, and the logical positivists. Recent translations have sparked interest in his works in English-speaking countries.

Brooks, Rodney Allen, an Australian professor of robotics, at Massachusetts Institute of Technology.

Since 1986, Rodney Allen Brooks has authored a series of highly influential papers, which have inaugurated a fundamental shift in artificial intelligence research. Outside the scientific community, Brooks is also known for his appearance in a film featuring him and his work, Fast, Cheap, and Out of Control. The focus of his research is the scientific approach of biologically-inspired robotics.

Brooks argued that interacting with the physical world is far more difficult than symbolically reasoning about it. Brooks focused instead on biologically-inspired robotic architectures (e.g., the sub-assumption architecture) that address basic perceptual and sensory-motor tasks.

Bruner, Jerome, American psychologist and educator, Microsoft® Encarta® 2007. © 1993-2006 Microsoft Corporation. All rights reserved.

A leading figure in the study of perception and language development. Under Bruner's leadership, researchers at the center brought together the methods and findings of experimental psychology, linguistics, child development, anthropology, artificial intelligence, and philosophy in the important new field of cognitive science.

Bruner's early work rejected the idea of perception as a passive recording of the external world presented to the senses. Rather, Bruner insisted, percepts are molded by a person's preconceived ideas. Bruner's view of human beings as active seekers of knowledge applies not only to adults but also to children. Bruner's discoveries about the meaning underlying children's games helped to modify views of child development.

Churchland, Paul and Patricia, Canadian philosophers, Microsoft® Encarta® 2007. © 1993-2006 Microsoft Corporation. All rights reserved; and Source: http://en.wikipedia.org/wiki/Patricia_Churchland

Noted for his studies in neurophilosophy and the philosophy of mind, Churchland is a major proponent of eliminative materialism, which claims that everyday mental concepts such as beliefs, feelings, and desires are part of a "folk psychology" of theoretical constructs without coherent definition, destined to simply be obviated by a thoroughly scientific understanding of human nature.

Churchland has focused on the interface between neuroscience and philosophy. According to her, philosophers are increasingly realizing that to understand the mind one must understand the brain. She is associated with a school of thought called eliminativism or eliminative materialism, which argues that folk psychology concepts such as belief, free will, and consciousness will likely need to be revised as science understands more about the nature of brain function.

Crick, Francis, British Biophysicist, Microsoft® Encarta® 2007. © 1993-2006 Microsoft Corporation. All rights reserved.

Co-winner of the 1962 Nobel Prize in physiology or medicine. Crick shared the prize with American biologist James D. Watson and British biophysicist Maurice Wilkins for their discoveries about the structure of deoxyribonucleic acid (DNA), the molecule that transmits genetic information from generation to generation.

Crick briefly pursued his doctoral degree studying the properties of water under high temperatures and pressures. There were two general areas he wished to pursue: what he later described as "the borderline between the living and nonliving" and neurobiology. He decided to initially concentrate on the first goal, studying the chemical components that form the basis of living things.

The deoxyribonucleic acid (DNA) molecule is the genetic blueprint for each cell and ultimately the blueprint that determines every characteristic of a living organism.

In 1953 American biochemist James Watson, and British biophysicist Francis Crick, described the structure of the DNA molecule as a double helix, somewhat like a spiral staircase with many individual steps. Their work was aided by X-ray diffraction pictures of the DNA molecule taken by British biophysicist Maurice Wilkins and British physical chemist Rosalind Franklin. In 1962 Crick, Watson, and Wilkins received the Nobel Prize for their pioneering work on the structure of the DNA molecule.

The deoxyribonucleic acid (DNA) molecule is the genetic blueprint for each cell and ultimately the blueprint that determines every characteristic of a living organism. In 1953 American biochemist James Watson, left, and British biophysicist Francis Crick, right, described the structure of the DNA molecule as a double helix, somewhat like a spiral staircase with many individual steps. Their work was aided by X-ray diffraction pictures of the DNA molecule taken by British biophysicist Maurice Wilkins and British physical chemist Rosalind Franklin. In 1962 Crick, Watson, and Wilkins received the Nobel Prize for their pioneering work on the structure of the DNA molecule.

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In 1949 Crick moved to the Cavendish Laboratory at Cambridge University to pursue his doctoral degree. Working under British physicist and Nobel laureate Sir William Lawrence Bragg, Crick studied the structure of proteins using X-ray diffraction. X-ray diffraction provides X-ray patterns of a molecule's chemical structure. He eventually moved to a unit of the Medical Research Council (MRC), a publicly funded laboratory located at Cambridge University. At MRC, Crick found himself in talented company. He worked under the guidance of Austrian-born British biochemist Max Perutz and alongside British chemist John Kendrew, two futures Nobel laureates. Crick initially studied the structure of hemoglobin, a red, iron-rich protein that carries oxygen in the blood. It was not long, however, before Crick became more interested in studying the structure of DNA.

In 1951 Watson joined Crick's laboratory at MRC. Crick and Watson shared the same passionate desire to determine the structure of DNA and, over the next two years, they worked together on

the problem. American biochemist Linus Pauling had earlier shown success in building scale models to identify the structure of proteins. Crick and Watson decided to use that approach to study DNA. At the time, Wilkins and British chemist Rosalind Franklin at King's College, London, were using X-ray diffraction analysis to study the DNA molecule. Crick and Watson applied the diffraction studies created by Wilkins and Franklin to their own research.

After a few missteps, Crick and Watson used the X-ray diffraction patterns created by Franklin to develop a three-dimensional model for the structure of DNA. This model depicted DNA as two complementary strands twisted into a double helix.

In 1953 Crick and Watson published their findings in the science journal Nature. Because of their work, scientists were able to understand and describe living things for the first time in terms of the structure and interaction of molecules. Recognized as one of the most significant discoveries of the 20th century, the identification of the structure of DNA affects practically every scientific discipline in the life sciences.

Genetics

He worked briefly with Watson on the structure of viruses. But he eventually returned to the study of DNA and his findings led to rapid advances in genetics. Crick and his coworkers determined how the order of bases, chemical subunits on the DNA structure, act as a code to determine the sequence of amino acids that make up proteins.

Darwin, Charles, British Scientist, Microsoft® Encarta® 2007. © 1993-2006 Microsoft Corporation. All rights reserved.

Darwin led the development of the theory of natural selection, which was to become the foundation concept supporting the theory of evolution. Darwin's theory holds that environmental effects lead to varying degrees of reproductive success in individuals and groups of organisms. Natural selection tends to promote adaptation in organisms when necessary for survival.

This revolutionary theory was published in 1859 in Darwin's now famous treatise "On the Origin of Species by Means of Natural Selection."

In the Galápagos Islands, off the coast of Ecuador, he also observed that each island supported its own form of tortoise, mockingbird, and finch; the various forms were closely related but differed in structure and eating habits from island to island.

Euclid, Greek Mathematician. Microsoft® Encarta® 2007. © 1993-2006 Microsoft Corporation. All rights reserved.

His chief work, Elements, is a comprehensive treatise on mathematics in 13 volumes on such subjects as plane geometry; proportion in general, the properties of numbers, incommensurable magnitudes, and solid geometry. Probably the geometrical sections of the Elements were

primarily a rearrangement of the works of previous mathematicians such as those of Eudoxus, but Euclid himself is thought to have made several original discoveries in the theory of numbers; and Euclid's Elements was used as a text for 2000 years.

Gottlob Frege (1848-1925), German Mathematician and Philosopher, Microsoft® Encarta® 2007. © 1993-2006 Microsoft Corporation. All rights reserved.

The founder of modern mathematical logic, Frege sought to derive the principles of arithmetic from the principles of logic. Faced with the ambiguity of ordinary language and the inadequacy of available logical systems, he invented many symbolic notations, such as quantifiers and variables, thus providing the foundation for modern mathematical logic. His work greatly influenced the British philosopher Bertrand Russell.

Freud, Sigmund, Austrian Physician, Microsoft® Encarta® 2007. © 1993-2006 Microsoft Corporation. All rights reserved.

Gall, Franz Joseph, German Anatomist and Physician, Microsoft® Encarta® 2007. © 1993-2006 Microsoft Corporation. All rights reserved.

Gall developed a system for studying the skull, called phrenology, which he claimed revealed the intelligence and personality of an individual. Gall believed that the contours of a person's skull indicate the areas of the brain that control particular abilities and emotions. Although phrenology is now considered a pseudoscience, Gall is recognized by the scientific community for his significant contributions to the early understanding of the locations of brain functions. He was the first scientist to identify the difference between gray and white matter in the brain and spinal cord.

19th Century: Gall's theory that mental functions are located in specific regions of the brain was proved correct by anatomical discoveries. But these same discoveries clearly proved that the skull is too thick to reflect locations of different mental functions of the brain.

Gödel, Kurt, American Logician, Microsoft® Encarta® 2007. © 1993-2006 Microsoft Corporation. All rights reserved.

Known primarily for his research in philosophy and mathematics, Gödel became prominent for a paper, published in 1931, setting forth what has become known as Gödel's proof. This proof states that the propositions on which the mathematical system is in part based are improvable because it is possible, in any logical system using symbols, to construct an axiom that is neither provable nor disprovable within the same system. To prove the self-consistency of the system, methods of proof from outside the system are required.

Gibson, James Jerome, American Psychologist, Microsoft® Encarta® 2007. © 1993-2006 Microsoft Corporation. All rights reserved.

Gibson proposed that perceptual information is gained directly from the environment, without the need for intermediate processing. He was an American psychologist who did influential and highly original work on visual perception. Gibson was an outspoken critic of German physiologist Hermann Helmholtz's notion that perception involves unconscious inferences from sense data and learning-based associations. Instead, Gibson proposed that perceptual information is gained directly from the environment, without the need for intermediate processing.

Gibson dispensed with the use of two-dimensional, static images and instead explored the perception of motion in freely moving subjects under natural conditions. He went on to develop what he called an ecological theory of perception in Senses Considered as Perceptual Systems (1966).

Husserl, Edmund, German Philosopher, Microsoft® Encarta® 2007. © 1993-2006 Microsoft Corporation. All rights reserved.

He wrote his doctoral thesis on the calculus of variations. He became interested in the psychological basis of mathematics and, shortly after becoming a lecturer in philosophy at the University of Halle, wrote his first book, Philosophie der Arithmetik (1891). At that time he maintained that the truths of mathematics have validity regardless of the way people come to discover and believe in them.

This 20th-century philosophical movement is dedicated to the description of phenomena as they present themselves through perception to the conscious mind. In this book, regarded as a radical departure in philosophy, he contended that the philosopher's task is to contemplate the essences of things, and that the essence of an object can be arrived at by systematically varying that object in the imagination.

Husserl noted that consciousness is always directed toward something. He called this directedness intentionality and argued that consciousness contains ideal, unchanging structures called meanings, which determine what object the mind is directed toward at any given time.

Husserl introduced the term phenomenological reduction for his method of reflection on the meanings the mind employs when it contemplates an object. Because this method concentrates on meanings that are in the mind, whether or not the object present to consciousness actually exists, Husserl said the method involves “bracketing existence,” that is, setting aside the question of the real existence of the contemplated object. He is considered the founder of phenomenology.

Huxley, Thomas, British Biologist, Microsoft® Encarta® 2007. © 1993-2006 Microsoft Corporation. All rights reserved.

Best known for his active support of Charles Darwin's theory of evolution, Huxley became thoroughly familiar with the surface animals of tropical seas. His observations on the medusa family of jellyfish led to the formulation of the zoological class Hydrozoa and to the realization that the two germ layers found in members of this class are comparable to the two germ layers that arise in the early embryological stages of higher animals. He used this time to write several scientific papers, including an authoritative work on the morphology of cephalopod mollusks.

James, Williams, American Philosopher and Psychologist, Microsoft® Encarta® 2007. © 1993-2006 Microsoft Corporation. All rights reserved.

Influenced by a theory of meaning and verification developed for scientific hypotheses by American philosopher C. S. Peirce, James held that truth is what works, or has good experimental results. In a related theory, James argued the existence of God is partly verifiable because many people derive benefits from believing. The work advanced the principle of functionalism in psychology, thus removing psychology from its traditional place as a branch of philosophy and establishing it among the laboratory sciences based on experimental method.

James developed the philosophy of pragmatism. He applied his empirical methods of investigation to philosophical and religious issues. He explored the questions of the existence of God, the immortality of the soul, free will, and ethical values by referring to human religious and moral experience as a direct source.

Kuhn, Thomas, American historian and philosopher of science, Microsoft® Encarta® 2007. © 1993-2006 Microsoft Corporation. All rights reserved.

A leading contributor to the change of focus in the philosophy and sociology of science in the 1960s, according to Kuhn, the sciences do not uniformly progress strictly by scientific method. There are two fundamentally different phases of scientific development in the sciences. In the first phase, scientists work within a paradigm (set of accepted beliefs). When the foundation of the paradigm weakens and new theories and scientific methods begin to replace it, the next phase of scientific discovery takes place.

Kuhn believes that scientific progress—that is, progress from one paradigm to another—has no logical reasoning. Kuhn's theory has triggered widespread, controversial discussion across many scientific disciplines.

Kurzweil, Raymond "Ray" is an American author, inventor and futurist, Wikipedia Encyclopedia, http://en.wikipedia.org/wiki/Ray_kurzweil

He was involved in fields such as optical character recognition (OCR), text-to-speech synthesis, speech recognition technology, and electronic keyboard instruments. Kurzweil is the author of several books on health, artificial intelligence (AI), transhumanism, the technological singularity, and futurism. Ray Kurzweil at age fifteen, wrote his first computer program. Designed to process statistical data, the program was used by researchers at IBM. Later in high school he

created a sophisticated pattern-recognition software program that analyzed the works of classical composers, and then synthesized its own songs in similar styles.

The capabilities of this invention were so impressive that, in 1965, he was invited to appear on the CBS television program I've Got a Secret, where he performed a piano piece that was composed by a computer he also had built.

Libet, Benjamin was a physiology researcher. A pioneering scientist in the field of human consciousness, in 2003, Libet was the first recipient of the Virtual Nobel Prize in Psychology from the University of Klagenfurt, "for his pioneering achievements in the experimental investigation of consciousness, initiation of action, and free will." Libet summarized his life's research and highlighted his work on conscious volitional acts and the antedating of sensory awareness.

Libet was involved in research into neural activity and sensation thresholds. His initial investigations involved determining how much activation at specific sites in the brain was required to trigger artificial somatic sensations, relying on routine psychophysical procedures. This work soon crossed into an investigation into human consciousness; his most famous experiment demonstrates that the unconscious electrical processes in the brain called Bereitschaft's potential. The experiment has caused controversy as it challenges the pre-scientific philosophical and religious views of "free will." It has also inspired further study.

Lorentz , Hendrik Antoon, Dutch Physicist and Nobel Laureate, Microsoft® Encarta® 2007. © 1993-2006 Microsoft Corporation. All rights reserved.

He developed the electromagnetic theory of light and the electron theory of matter and formulated a consistent theory of electricity, magnetism, and light. With the Irish physicist George Francis FitzGerald, he formulated a theory on the change in shape of a body resulting from its motion; the effect, known as the Lorentz-FitzGerald contraction, was one of several important contributions that Lorentz made to the development of the theory of relativity. For his explanation of the phenomenon known as the Zeeman effect, Lorentz shared the 1902 Nobel Prize in physics with the Dutch physicist Pieter Zeeman.

Malebranche, Nicolas, French Philosopher, Microsoft® Encarta® 2007. © 1993-2006 Microsoft Corporation. All rights reserved.

He developed a metaphysical theory called occasionalism. The doctrine of occasionalism denies the possibility of any action of matter upon mind. Malebranche argued that “we see all things in God.” Since human knowledge is possible only through interaction between a human being and God, changes in objects or thoughts are caused by God, not by the objects or individuals. He also wrote on the nature of light and color, the psychology of vision, and calculus.

McCulloch, Warren Sturgis, American Neurophysiologist, Microsoft® Encarta® 2007. © 1993-2006 Microsoft Corporation. All rights reserved.

He developed cybernetic and computational models of the brain. An American neurophysiologist who developed cybernetic and computational models of the brain. His work on brain models was undertaken initially at the University of Illinois. McCulloch's papers include "What the Frog's Eye Tells the Frog's Brain" (1959), which detailed the way in which information is transmitted from the retina to the brain to detect significant features or events in the frog's environment.

Mesmer, Franz Austrian Physician, Microsoft® Encarta® 2007. © 1993-2006 Microsoft Corporation. All rights reserved.

Moravec, Hans, Robotic expert, Microsoft® Encarta® 2007. © 1993-2006 Microsoft Corporation. All rights reserved.

Experts in robotics and computer technology are constantly expanding the possibilities for creating "intelligent" machines. Robotics expert Hans Moravec suggests that it will be possible in the future to transfer a human personality into a robot. Some futurists even speculate that it will be possible to transfer a complete human mind from one body to another, allowing humans to achieve a kind of immortality.

Napier, John, 16th Century Scottish Mathematician, Microsoft® Encarta® 2007. © 1993-2006 Microsoft Corporation. All rights reserved.

Napier is best known as the inventor of the first system of logarithms, described in Canonis Descriptio (1614). The common and natural systems of logarithms used today do not employ the same base as Napier's logarithms, although natural logarithms are sometimes called Napierian logarithms. He was one of the first, if not the first, to use the decimal point in expressing decimal fractions in a systematic way and according to the modern system of decimal notation. He also invented mechanical systems for performing arithmetical computations, described in Rabdologia (1617).

Neumann, John von, Hungarian-American Mathematician, Microsoft® Encarta® 2007. © 1993-2006 Microsoft Corporation. All rights reserved.

Summary of the Chronology

Thales

Thales became famed for his knowledge of astronomy after predicting the eclipse of the sun that occurred on May 28, 585 BC. He is also said to have introduced geometry in Greece. This method of deductive reasoning has dominated all geometry, and in fact all mathematics, to the

present day. According to Thales, the original principle of all things is water, from which everything proceeds and into which everything is again resolved. Thales is credited with several simple but important theorems, including the proof that an angle inscribed in a semicircle is a right angle. This method of deductive reasoning has dominated all geometry, and in fact all mathematics, to the present day.

Pythagoras

The Pythagoreans adhered to certain mysteries: Obedience and silence, abstinence from food, simplicity in dress and possessions, and the habit of frequent self-examination were prescribed. The Pythagoreans believed in immortality and in the transmigration of souls.

Pythagoras in the 6th century BC emphasized the study of mathematics as a means to understanding all relationships in the natural world. His followers, known as Pythagoreans, were the first to teach that the Earth is a sphere revolving around the Sun. Pythagoras (582?-500?BC), Greek philosopher and mathematician, whose doctrines strongly influenced Plato. The philosophy of Pythagoras is known only through the work of his disciples.

He created the Pythagorean theorem. The Pythagorean theorem states that in a right triangle the sum of the squares of the legs, a and b, is equal to the square of the hypotenuse, c. In other words, A + B = C, or $a^2 + b^2 = c^2$. The theorem is attributed to Greek mathematician and philosopher Pythagoras, who lived in the 6th century BC. Among the extensive mathematical investigations carried on by the Pythagoreans were their studies of odd and even numbers and of prime and square numbers

Plato

Plato points upward to the world of ideas, where he believes knowledge lies, whereas Aristotle holds his forearm parallel to the earth, stressing observation of the world around us as the source of understanding. Plato, one of the most famous philosophers of ancient Greece, was the first to use the term philosophy, which means “love of knowledge.” The goal of the philosopher, according to Plato, is to know the perfect forms and to instruct others in that knowledge. Plato (428?-347 BC), Greek philosopher, one of the most creative and influential thinkers in Western philosophy.

He eventually became a disciple of Socrates, accepting his basic philosophy and dialectical style of debate: the pursuit of truth through questions, answers, and additional questions. Plato witnessed the death of Socrates at the hands of the Athenian democracy in 399 BC. The earliest collection of Plato’s work includes 35 dialogues and 13 letters. Plato’s attempt to communicate the philosophy and dialectical style of Socrates. Socrates emerged as the wiser one because he at least knows that he does not know.

Plato’s rejection of empiricism, the claim that knowledge is derived from sense experience. He thought that propositions derived from sense experience have, at most, a degree of probability.

They are not certain. Plato extended his theory beyond the realm of mathematics. Indeed, he was most interested in its application in the field of social ethics.

Plato defined a circle. A circle, for instance, is defined as a plane figure composed of a series of points, all of which are equidistant from a given point. Plato's own theory of knowledge is found in the Republic, particularly in his discussion of the image of the divided line and the myth of the cave. Plato distinguishes between two levels of awareness: opinion and knowledge. Aristotle was the Plato Academy's most prominent student.

Aristotle

Aristotle shared his teacher's reverence for human knowledge but revised many of Plato's ideas by emphasizing methods rooted in observation and experience. Aristotle surveyed and systematized nearly all the extant branches of knowledge and provided the first ordered accounts of biology, psychology, physics, and literary theory. Aristotle invented the field known as formal logic, pioneered zoology, and addressed virtually every major philosophical problem known during his time. Aristotle is possibly the greatest thinker in Western history and, historically, perhaps the single greatest influence on Western intellectual development.

Aristotle's school came to be known as the Peripatetic ("walking" or "strolling") school. Aristotle, like Plato, made regular use of the dialogue in his earliest years at the Academy, but lacking Plato's imaginative gifts, he probably never found the form congenial. Aristotle's philosophy laid its principal stress on biology, in contrast to Plato's emphasis on mathematics. Aristotle proposed a finite, spherical universe, with the earth at its center. The central region is made up of four elements: earth, air, fire, and water.

Aristotle challenged the Pythagorean doctrine that the soul is a spiritual entity imprisoned in the body. Aristotle's doctrine is a synthesis of the earlier notion that the soul does not exist apart from the body and of the Platonic notion of a soul as a separate, nonphysical entity. Human nature certainly involves, for everyone, a capacity for forming habits; but the habits that a particular individual forms depend on that individual's culture and repeated personal choices.

Acquinas rested on Aristotle's work until British scientist Charles Darwin modified the doctrine of the changelessness of species in the 19th century. Moral virtues are habits of action that conform to the golden mean, the principle of moderation, and they must be flexible because of differences among people and conditioning factors. Aristotle defines the mean as being between the two extremes of excess and insufficiency; thus, generosity is the mean between prodigality and stinginess. For Aristotle, the intellectual and the moral virtues are merely means toward the attainment of happiness, which results from the full realization of human potential.

Aristotle had the misconception that the heart was the seat of emotions and the brain was air conditioning system to cool the blood. Aristotle tutored Alexander the Great. Aristotle's works became so influential that they determined the course of Western scientific thought until modern

times. He also held that heavier bodies of a given material fall faster than lighter ones when their shapes are the same, a mistaken view that was accepted as fact until the Italian physicist and astronomer Galileo conducted his experiment with weights dropped from the Leaning Tower of Pisa.

The Antikythera mechanism, a Greek device, was used to calculate solar, lunar, and astrological positions. Found in 1902 from an ancient shipwreck, the Antikythera machine was a clockwise mechanism capable of predicting the motion of the moon and planets. Aristotle thought, when some "very low" worms and flies come from rotting fruit or manure by "spontaneous generation."

French Philosopher, attempted during the 17th-century to explain the interrelationship between mind and body and concluded that God is the only cause. In 1619, Rene Descartes experienced a dream: A dream of science of the future that would make clear the difference realms of matter and mind. Rene Descartes envisaged a new science in a series of dreams. In 1633, Descartes had completed his work "De Mundo." Because Galileo had been convicted by the Catholic Church for similar arguments. Descartes decided to suppress the book.

Epiphenomenalism has its roots in the theory of dualism, especially as formulated by Descartes, who pondered this perceived distinction between mind and matter. Real Roots also had an extensive history, from Descartes' influence on the golden age of automata to their impressive use in various fields today. Baruch Spinoza was one of the most influential monists. He taught that both material and spiritual phenomena are attributes of one underlying substance. His doctrine strongly anticipated the mind-stuff theory.

1664: Descartes also described the circulation of the blood but came to the erroneous conclusion that heat in the heart expands the blood, causing its expulsion into the veins. According to Descartes, a human being is a union of mind and body, two radically dissimilar substances that interact in the pineal gland. He reasoned that the pineal gland must be the uniting point because it is the only non-double organ in the brain, and double reports, as from two eyes, must have one place to merge. He argued that each action on a person's sense organs causes subtle matter to move through tubular nerves to the pineal gland, causing it to vibrate distinctively. These vibrations give rise to emotions and passions and also cause the body to act.

Descartes argued further that human beings can be conditioned by experience to have specific emotional responses. Descartes himself, for example, had been conditioned to be attracted to cross-eyed women because he had loved a cross-eyed playmate as a child. When he remembered this fact, however, he was able to rid himself of his passion. Descartes also held that, unless people believe in God and immortality, they will see no reason to be moral.

Descartes argued further that human beings can be conditioned by experience to have specific emotional responses. Descartes himself, for example, had been conditioned to be attracted to cross-eyed women because he had loved a cross-eyed playmate as a child. When he remembered this fact, however, he was able to rid himself of his passion.

Descartes also held that, unless people believe in God and immortality, they will see no reason to be moral. Free will, according to Descartes, is the sign of God in human nature, and human beings can be praised or blamed according to their use of it. People are good, he believed, only to the extent that they act freely for the good of others. Such generosity is the highest virtue.

In 1623, William Strickland mechanizes Napier's bones. After a visit with Kepler, William Schickard produced a machine capable of multiplying.

In 1632-1633, Galileo published "Dialogue Concerning the Two World Systems" and is the tried for suspicion of Heresy by the Catholic Church.

In 1642, Blaise Pascal, philosopher and mathematician, produced the Pascaline.

French philosopher, mathematician, and physicist Blaise Pascal invented a machine in 1642 that added and subtracted, automatically carrying and borrowing digits from column to column. Pascal built 50 copies of his machine, but most served as curiosities in parlors of the wealthy.

In 1666, Isaac Newton, prism experiments on color. Newton's experiment lays the groundwork for our contemporary understanding of color in terms of wavelength. Goethe claims that Newton's approach is inadequate. Color exists only in the mind. In 1689, John Locke: "In his Essay Concerning Human Understanding," gives a functional account of when someone is the same man. In order for someone to be the same man, the same functional organization must be continuous over time.

18th Century: Includes phrenology, a theory formulated by the German physician Franz Joseph Gall, believed that examination of the skull of an individual would reveal information about mental functions. The theory of animal magnetism developed by the Austrian physician Franz Mesmer was based on the existence of a magnetic force having a powerful influence on the human body.

During the 18th-19th Centuries, Phrenology is based on the work and theories of Franz Joseph Gall, a German anatomist of the late 18th and early 19th centuries. The term phrenology was adopted by Gall's student and coworker, Johann Caspar Spurzheim. According to Gall's theory, the brain is composed of many areas, each of which governs different personality traits and intellectual abilities. The strength or weakness of each trait or ability is determined by the size of the area where it is centered.

The idea of repression was introduced in the late 19th century by Austrian physician Sigmund Freud, the founder of psychoanalysis. According to Freudian theory, people banish unpleasant events into their unconscious mind. However, repressed memories may continue to unconsciously influence people's attitudes and behaviors and may result in unpleasant side effects, such as unusual physical symptoms and slips of speech. Gall's theory that mental functions are located in specific regions of the brain was proved correct by anatomical discoveries in the mid-19th century. But these same discoveries clearly proved that the skull is too thick to reflect locations of different mental functions of the brain.

In 1831, the young Charles Darwin was fascinated by differences in the Galapagos finches. Why are there so many different kinds of finches? Darwin concluded that so many different kinds of finches exist because so many different environments exist. Environmental pressure is a crucial element in the evolutionary process. It is environments that do the selection in natural selection.

1850: Thomas Huxley became thoroughly familiar with the surface animals of tropical seas. His observations on the medusa family of jellyfish led to the formulation of the zoological class Hydrozoa and to the realization that the two germ layers found in members of this class are comparable to the two germ layers that arise in the early embryological stages of higher animals.

1861: James Clark Maxwell lays the foundations for color Photography. His experiment showed that our visual system would feed only three types of color receptors to capture the full spectrum of colors we see. Edwin Land offered an even more startling experiment regarding color, concentrating on the contrast effect.

William James' first book, the "Monumental Principles of Psychology" (1890), established him as one of the most influential thinkers of his time. The work advanced the principle of functionalism in psychology, thus removing psychology from its traditional place as a branch of philosophy and establishing it among the laboratory sciences based on experimental method. In the mid 1900s, psychologists engaged in the "search for the engram." They used the term

engram to refer to the physical change in the nervous system that occurs as a result of experience.

In 1905, French psychologists Alfred Binet and Theodore Simon developed one of the first tests to measure the intelligence of children. Test items were grouped by the age at which most children could complete them. These tasks were included on the 1911 version of the test. In 1906, the most common known cause of severe memory loss, or dementia, is Alzheimer's disease—brain lesions first identified by German neuro-pathologist Alois Alzheimer in 1906. It strikes between 5 and 10 percent of all people over 65 and one-quarter to one-half of those over 85.

Bertrand Russell and Alfred North Whitehead wrote Principia Mathematica. Bertrand Russell and Alfred North Whitehead developed and wrote the Principia of Mathematica-the foundation of computer logic. It took them 10 years to develop this concept and printed in three volumes. The purpose of Principia was to prove that all mathematics was essentially logic. Logical symbols: And, Or, Not, were enough to give all the numbers, functions, operations, and transformations of mathematics.

In 1930, before the War World II, Alan M. Turing had developed the Turing machine, as abstract model of the concept of computation in general. He developed a general conception of computation, Turing machine-step by step machine: The Turing machine, thought of as operating step by step on individual symbols. How it functions at any step depended on it sinner states, but the symbols also change its inner states.

Turing also showed that there were things that no Turing machine could calculate. One example is the haling problem: No Turing machine could predict in all cases whether a Turing machine will go into an infinite loop. Al Turing, while he was still a graduate student, Turing published a paper called “On Computable Numbers,” which introduced the concept of a theoretical computing device now known as a Turing machine. The concept of this machine, which could theoretically perform any mathematical calculation, was important in the development of the digital computer. Turing also extended his mathematical work to the study of artificial intelligence and biological forms. He proposed a method called the Turing test, to determine whether machines could have the ability to think.

In 1950, Turing published “Computer Machinery and Intelligence” in the philosophical journal “Mind.” That article gave us the Turing test. Turing outlines the Turing test in terms of an analogous party game: In the machine game, the question is whether you can differentiate a woman from a man pretending to be a woman when both are behind a door and providing written answers to written questions.

Turing made a prediction: “I believe that in fifty years time, it will be possible to program computers to play the imitation game so well that an average interrogator will not have more than 70% chance of making the right identification in five minutes of questioning.”

In the 1940’s, the first working models are those of Warren McCullough and Walter Pitts. Although hemispherectomies were performed in the 1940s, few patients lived. Pediatric neurosurgeons revitalized the procedure in the mid-1980s, because of advances in brain scans and in ability to combat bleeding. Several dozen hemispherectomies are performed each year now in the United States, usually as treatment for Rasmussen's encephalitis and forms of epilepsy that destroy the cortex but do not cross the groove separating left and right hemispheres. Patients can live because neither the disease nor the operation touches areas that control basic functions: the cerebellum, which coordinates movement; the diencephalon, which facilitates emotions and regulates body functions; and the brain stem, which maintains breathing, heart rate, and other life-support systems.

In 1948, Skinner became the foremost exponent in the U.S. of the behaviorist school of psychology, in which human behavior is explained in terms of physiological responses to external stimuli. He also originated programmed instruction, a teaching technique in which the student is presented a series of ordered, discrete bits of information, each of which he or she must understand before proceeding to the next stage in the series. A variety of teaching machines have been designed that incorporate the ideas of Skinner. In 1949, Gilbert Ryle, the Concepts of Mind.

In The Concept of Mind (1949) he employed this procedure in attacking mentalistic language, which suggests that the mind is an entity in the same way as the body. Francis Crick initially studied the structure of hemoglobin, a red, iron-rich protein that carries oxygen in the blood. It was not long, however, before Crick became more interested in studying the structure of DNA.

In the 1950-66 timeframe, in his experimental work, J.J. Gibson dispensed with the use of two-dimensional, static images and instead explored the perception of motion in freely moving subjects under natural conditions. He published his results in “The Perception of the Visual World.” He went on to develop what he called an ecological theory of perception in Senses Considered as Perceptual Systems.

Robotic development has increased dramatically since the 20th Century. It focuses in particular n contemporary robots, emphasizing both the promise they may offer and the threat they may pose.

Watson joined Crick’s laboratory at MRC. Crick and Watson shared the same passionate desire to determine the structure of DNA and, over the next two years, they worked together on the problem. American biochemist Linus Pauling had earlier shown success in building scale models to identify the structure of proteins. Crick and Watson decided to use that approach to study DNA. At the time, Wilkins and British chemist Rosalind Franklin at King’s College,

London, were using X-ray diffraction analysis to study the DNA molecule. Crick and Watson applied the diffraction studies created by Wilkins and Franklin to their own research.

In closing, about 1953, American biochemist James Watson and British biophysicist Francis Crick described the structure of the DNA molecule as a double helix, somewhat like a spiral staircase with many individual steps. Their work was aided by X-ray diffraction pictures of the DNA molecule taken by British biophysicist Maurice Wilkins and British physical chemist Rosalind Franklin.

Crick and Watson published their findings in the science journal Nature. Because of their work, scientists were able to understand and describe living things for the first time in terms of the structure and interaction of molecules. Recognized as one of the most significant discoveries of the 20th century, the identification of the structure of DNA affects practically every scientific discipline in the life sciences.

Chronology - Philosophy of Mind

Date of Event: Event Description

2500 BC: The Stonehenge Eclipse predicting device.

800 BC: Homer, Iliad and Odyssey

347-322 BC: Aristotle, Prior Analytics, Posterior Analytics, De Interpretatione.

100 BC: The Antikythera mechanism, a Greek device used to calculate solar, lunar, and astrological positions. Found in 1902 from an ancient shipwreck. The Antikythera machine was a clockwise mechanism capable of predicting the motion of the moon and planets.

100 BC-100 AD: Hero of Alexandria constructed a series of steam driven religious altars, some of which incorporated moving statuses.

8 AD: Ovid Metamorphoses

1600-1800: The golden Age of Automata.

16^{th}-17^{th} Centuries: Real Robots also have an extensive history, from Descartes' influence on the golden age of automata to their impressive use in various fields today. It is explored our enduring fascination with robots by tracing their memory in both art and reality.

1352-54: Strasbourg Clock was built.

1354: Strasbourg clock incorporated several automata.

16th Century: Italian philosopher Machiavelli wrote, "Whoever wishes to foresee the future must consult the past; for human events ever resemble those of preceding times."

1495: Leonardo da Vinci may have built a moving knight robot in armor.

1600-1800: The Golden Age of Automata. A series of machines in the 1600's began to look more like a computing machine.

16th-17th Centuries: Real Robots also have an extensive history, from Descartes' influence on the golden age of automata to their impressive use in various fields today. It is explored our enduring fascination with robots by tracing their memory in both art and reality.

17th-century Dutch philosopher Baruch Spinoza was one of the most influential monists. He taught that both material and spiritual phenomena are attributes of one underlying substance. His doctrine strongly anticipated the mind-stuff theory.

Epiphenomenalism has its roots in the theory of dualism, especially as formulated by 17th-century French philosopher René Descartes, who pondered this perceived distinction between mind and matter. French philosopher René Descartes concluded that God is the only cause.

1614: John Napier invents logarithm. Napier also invented logarithms, which allow the multiplication of two numbers by adding their exponents.

1617-1885: John Napier of Scotland introduced two ways o f handling multiplication in terms of addition. Napier bones: It was the first pocket calculator. Napier's bones was a set of ivory sticks marked with numbers that could be used to multiply merely by adding.

1619: Rene Descartes experienced a dream. A dream of science of the future that would make clear the difference realms of matter and mind. Rene Descartes envisaged a new science in a series of dreams. He was 23 years old at this time.

We have drawn from ancient, classical, and contemporary philosophy in pursuing issues of mind, using a wealth of thought experiments. The emphasis throughout has been on the force of argument in deciding between intellectual options and positions.

1623: William Strickland mechanizes Napier's bones. After a visit with Kepler, William Schickard produced a machine capable of multiplying.

1632-1633: Galileo publishes Dialogue Concerning the Two World Systems and is tried for suspicion of heresy by the Catholic Church.

1629-1649: Rene Descartes, Meditations on First Philosophy, Passions of the Soul, De Mundo. Descartes had completed his work "De Mundo." Because Galileo had been convicted by the Catholic Church for similar arguments, Descartes decided to suppress the book. The view of

animals and machines in “De Mundo” was developing in his later work. Galileo was sentenced to house arrest and his health slowly decayed.

1642-1662: Blaise Pascal, philosopher and mathematician, produced the Pascaline. Blaise Pascal invents the Pascaline, calculator and writes Pensees.

1651-1655: Thomas Hobbes, Leviathan and De Corpore.

1655: Plank by plank, each part of the ship was replaced. In his “De Corpore“ Thomas Hobbes adds a further spin: What if the old pieces are crutched together in the junk yard?
1664: Descartes also described the circulation of the blood but came to the erroneous conclusion that heat in the heart expands the blood, causing its expulsion into the veins. Report was published.

According to Descartes, a human being is a union of mind and body, two radically dissimilar substances that interact in the pineal gland. He reasoned that the pineal gland must be the uniting point because it is the only nondouble organ in the brain, and double reports, as from two eyes, must have one place to merge. He argued that each action on a person's sense organs causes subtle matter to move through tubular nerves to the pineal gland, causing it to vibrate distinctively. These vibrations give rise to emotions and passions and also cause the body to act.

The mind cannot change bodily reactions directly—for example, it cannot will the body to fight—but by altering mental attitudes, it can change the pineal vibrations from those that cause fear and fleeing to those that cause courage and fighting.

1666: Isaac Newton, prism experiments on color. Newton experiment lays the groundwork for our contemporary understanding of color in terms of wavelength. Goethe claims that Newton’s approach is inadequate. Color exists only in the mind.

1672-1715: Gottfried Wilfred Leibnitz builds a multiplying machine.

1687: Isaac Newton, Philosophiae Naturalist Principia Mathematica.

1688: The history of Molyneux (Irish) wrote John Locke a letter in which he asked whether a man who had been blind from birth but who had learned to distinguish shapes by touch would recognize those shapes by sight when his vision was restored. Locke claimed that he would not, and Leibnitz gave a different answer.

1689: John Locke: In his essay “Concerning Human Understanding,” he gives a functional account of when someone is the same man. In order for someone to be the same man, the same functional organization must be continuous over time. The theory appears with variations in the work of the Empiricists: John Locke, Bishop Berkeley, and David Hume, writing in the first half of the 1700’s.

1700-1800's: Anticipations of the idea of associate learning appear in the work of David Hume and John Stuart Mill.

The 18th century includes phrenology, a theory formulated by the German physician Franz Joseph Gall, who believed that examination of the skull of an individual would reveal information about mental functions. The theory of animal magnetism developed by the Austrian physician Franz Mesmer was based on the existence of a magnetic force having a powerful influence on the human body.

German physician and chemist Georg Ernst Stahl coined the word *animism* to describe his theory that the soul is the vital principle responsible for organic development. Since the late 19th century, however, the term has been mainly associated with anthropology and the British anthropologist Sir Edward Burnett Tylor who described the origin of religion and primitive beliefs in terms of animism.

1737: Jacques de Vaucanson builds his famous automatons.

1748: David Hume, "An Enquiry Concerning Human Understanding," and Julien Offray de La Mettrie, "Man and Machine."

1769: Wolfgang von Kempelen creates a fake chess playing Automaton. Some touted automata, including Wolwang von Kempelen's (1734-1804) chess playing Turk, were fakes. All of these automata lacked genuine autonomy.

1781: Immanuel Kant, "The Critique of Pure Reason."

18th-19th Centuries: The history of automata continues with increasingly sophisticated machines and all the way up to Walt Disney's theme park attractions Mr. Lincoln and Pirates of the Caribbean.

1800's: Francis Hall's phrenology was based on the concept of localizing mental faculties and personality characteristics in distinct places in the head. The term phrenology was adopted by Gall's student and coworker, Johann Caspar Spurzheim. According to Gall's theory, the brain is composed of many areas, each of which governs different personality traits and intellectual abilities. The strength or weakness of each trait or ability is determined by the size of the area where it is centered. For example, Gall believed that the trait of benevolence arose from an area of the brain at the top-front of the head, and that the area for the trait of reverence was located directly behind the benevolence brain area. Gall believed he could tell how benevolent or reverent a person was simply by feeling the size and shape of the skull over these areas.

The work of Franz Brentano, the "aboutness" of perception is essential to it. Brentano's slogan "all perception is perception of." The strange story of Oliver Sacks' patient who mistook his wife's head for his hat fits the theory nicely. So does a wide range of other work in the brain sciences on agnosia and prosoagnosia -- the inability to recognize faces. The term Intentionalist comes from a term used by the Scholastic philosopher of the middle Ages to mean "conceptual content."

Logic was reborn through the work of George Boole and Got lob Frege. The goal was the same as it had been for Aristotle, to systematize, formalize, and mechanize thought.

By the end of this century, scientists were measuring the skulls of living people using the cranial index. One of those scientists was Alfred Binet, who measured the skulls of French school children. He knew that neurons function electrically was a breakthrough in the 1800's, but the process is actually electrochemical rather than purely electrical. One clue is the fact that the electrochemical process operates much more slowly than purely electrical system would. In the process of transferring an electrical potential down the axon, potassium, sodium, and calcium ions leave and enter the neuron.

Many scholars turned away from what they considered subjective and anecdotal methods of describing races. They devised techniques to measure the physical attributes of people, a practice known as *anthropometry.* Scientists became especially interested in *craniometry* (the measurement of head shape and size), inspired partly by the popularity in the early 1800s of phrenology, the study of the link between head shape and mental abilities.

1800-1821: Francis Gall developed phrenology.

1801: Jacquard's loom, an important step in the history of computing devices. The design is amazing contemporary, with a mill and a store corresponding to the central processor and memory of contemporary computers. Processing was to be carried out on punched cards, invented for the Jacquard loom.

1810: Johann Wolfgang von Goethe, Theory of Colors.

1816: He became a fellow of the Royal Society in 1816 and was active in the founding of the Analytical, the Royal Astronomical, and the Statistical societies.

1820: This woodcut shows a small portion of the ingenious machine, which was designed by Charles Babbage in the 1820s. Although the device did not have a memory, Babbage's later idea for the Analytical Engine would have been a true, programmable computer if the technology of his time had been able to build it.

1820-1840: Charles Babbage, Different Engines 1 and 2 Analytical Engine. Babbage took great delight in finding errors in published logarithms tables. He designed a machine to calculate

logarithms and print them mechanically. The crucial concept of logic began with Aristotle. It was a special purpose computer designed to calculate logarithms by using a steam machine. The Babbage Difference Engine exhausted Parliament financial patience. If the Analytical Machine had been built, it would have been a full-fledged computer constructed of steel and brass and driven by steam. It was never completed.

1821-51: During this period, Samuel George Morton amassed more than 600 human skulls. When he measured cranial capacity, Morton found Caucasians (German, British, and Irish) to have biggest brains, followed by Asians, Native Americans, and those of African descent.

1830s-1840: Morton conducted various measurements, including cranial capacity, of more than 1,000 skulls. Based on these studies, Morton concluded that the various human races did not share a common ancestor and were probably unrelated to one other.

1831: The young Charles Darwin was fascinated by differences in the Galapagos finches. Why are there so many different kinds of finches? Darwin concluded that so many different kinds of finches exist because so many different environments exist. Environmental pressure is a crucial element in the evolutionary process. It is environments that do the selection in natural selection.

1831: John Bull's locomotive machine was designed.

1836: Southern literacy messenger industrial Robots are used as Spot Welders in Japan. Fifty percent of the world's robots are in Japan.

1848: An explosion drives a steel bar through Phineas Gage's Head. A railroad foreman, Gage survived the accident, but he underwent a radical personality change. Together with the story of phrenology (study of bumps on the skull), the strange case of Phineas Gage is used to explore the history of basic question about mental faculties and brain.

1851: After Morton's death in 1851, some of his associates used his work to justify the institution of slavery in the American South, arguing that blacks were distinctly different from whites and biologically inferior. Morton also influenced French anthropologist Paul Broca, who elaborated on polygenic theory and developed new instruments to measure the skull. Modern critics of Morton's work argue that his measurements contained errors that reflected an unconscious racial bias.

1854: George Boole, "An Investigation of the Laws of Thought, on which are founded the Mathematical Theories of Logic and Probabilities."

1859: Charles Darwin, "On the Origin of Species."

1861-64: James Clerk Maxwell "Dynamic Theory of the Electro Magnetic Field." Laid the foundation for color photography. His experiment showed that our visual system would feed only three types of color receptors to capture the full spectrum of colors we see. Edwin Land offered an even more startling experiment regarding color, concentrating on the contrast effect.

1871: British anthropologist Sir Edward Burnett Tylor, described the origin of religion and primitive beliefs in terms of animism. In *Primitive Culture* (1871) Tylor defined animism as the general belief in spiritual beings and considered it "a minimum definition of religion." He asserted that all religions, from the simplest to the most complex, involve some form of animism. According to Tylor, primitive peoples, defined as those without written traditions, believe that spirits or souls are the cause of life in human beings.

1872: Charles Darwin, Expression of the Emotions in Man and Animals.

1874: Franz Brentano, Psychology from the Empirical Standpoint; T. H. Huxley, "On the Hypothesis that Animals are Automata, and it's History."

A German neurologist, Carl Wernicke, reported in 1874 that people with damage to a different area of the left hemisphere lose their ability to comprehend speech. This region became known as *Wernicke's area.*

1879-1887: Extreme or absolute materialism is known as materialistic monism. According to the mind-stuff theory of monism, as expounded by the British metaphysician W. K. Clifford, in his *Elements of Dynamic* (1879-87), matter and mind are consubstantial, each being merely an aspect of the other.

1882: By the criteria adopted into American law (1882), a defendant is "not guilty by virtue of insanity" if he or she did not know the nature and quality of the act or did not know that the act was wrong as a result of laboring under a defect or reason from disease of the mind.

1889-1951: Ludwig Wittgensteins, outstanding philosopher, was the son of the richest family in Austria. His brother lost his arm in a war-outstanding piano player. Three of his brothers committed suicide. He writes in metaphors, and argues within him; charisma was irrescitable.

1890: William James, The Principles of Psychology.
1890: Jean Leon Gerome painted the theme of Pygmalion twice from different angles.

1891: Sigmund Freud, On Aphasia

1892: Hendricks Lorentz develops the Lorentz field equation.

1896: Psycho analysis – break of Psychology of Mind and Psychology.

1900: Gilbert Ryle. If you want absolute certainty, you start by throwing out everything that might in any way be subject to doubt.

1904: Alfred Binet develops an intelligence test that lays the foundation for IQ testing.

1905: French psychologists Alfred Binet and Théodore Simon developed one of the first tests to measure the intelligence of children. Test items were grouped by the age at which most children could complete them. These tasks were included in the 1911 version of the test.

1906: The most common known cause of severe memory loss, or dementia, is Alzheimer's disease—brain lesions first identified by German neuro-pathologist Alois Alzheimer in 1906. It strikes between 5 and 10 percent of all people over 65 and one-quarter to one-half of those over 85. Genetic mutation is a suspect but accounts for only 10 percent of all cases. "Early-onset" Alzheimer's, which begins around 40 or 50, runs in some families. Some Alzheimer's in older people is associated with defects in another gene that makes a protein, apolipoprotein E, that ferries cholesterol in the bloodstream and helps regenerate nerve cells. No one yet knows how it relates to neural tangles and nerve cell death.

1910-1913: Bertrand Russell and Alfred North Whitehead wrote "Principia Mathematica" the foundation of computer logic. It took them 10 years to develop this concept and print in three volumes. The purpose of Principia was to prove that all mathematics was essentially logic. Logical symbols: AND, OR NOT-were enough to give all the numbers, functions, operations, and transformations of mathematics.

1910: Many people learned in school that we use only 10 percent of our brains, a belief that may have been based on psychologist William James's assertion in 1910 that we use "only a small part" of our mental powers. People like Matt certainly indicate that much of the brain is redundant. I can imagine Matt telling his dates ten years from now, "You won't believe this, but I have half a brain."

1915: By the time the golem appears in film, he runs amok.

1916: Ovid's myth inspired George Bernard Shaw's play, Pygmalion, which was the basis for the musical "My Fair Lady." The Pygmalion theme appears again in the movie "Blade Runner."

1921: Ludwig Wittgenstein, Tractatus Logico Philosophicus.

The term robot was introduced in Karel Capek's play R.U.R. (Rosum's Universal Robots) first performed.

1924: During WWI, IQ tests were used for officer's selection. Test conditions were poor and uneven, and the results were influential in passing the Immigration Restriction ACT.

1924: Clarence Darrow sued the problem of free will and determinism in defending Nathan Leopold and Richard Loeb. Darrow was successful; the two men were not hanged but were sentenced to life imprisonment.

1927: In Fritz Lang's Metropolis, a female robot tries to destroy both people and machines.

In Buck vs. Bell, the Supreme Court upheld in Virginia a law that called for sterilization of the mentally inferior. Although many states have rescinded similar laws, the decision in Buck vs. Bell has never been officially overturned.

1930: Before the war, Turing had developed the Turing machine, as abstract model of the concept of computation in general. Alan M. Turing developed a general conception of computation, Turing machine-step by step machine: The Turing machine, thought of as operating step by step on individual symbols. How it functions at any step depended on it sinner states, but the symbols also change its inner states.

Turing also showed that there were things that no Turing machine could calculate. One example is the haling problem: No Turing machine could predict in all cases whether a Turing machine will go into an infinite loop.

1931: Kurt Godel, on formally "Undecidable Propositions of Principia Mathematica" and related systems, Godel's incompleteness theorem.

1937: Alan M. Turing creates the Turing machine theory of computation.

1938: B.F. Skinner, "The Behavior of Organisms."

In 1938 American psychologist Louis L. Thurstone proposed that intelligence was not one general factor, but a small set of independent factors of equal importance. He called these factors *primary mental abilities.* To identify these abilities, Thurstone and his wife, Thelma, devised a set of 56 tests.

1940's: The first working models are those of Warren McCullough and Walter Pitts.

Although hemispherectomies were performed in the 1940s, few patients lived. Pediatric neurosurgeons revitalized the procedure in the mid-1980s because of advances in brain scans and in ability to combat bleeding. Several dozen hemispherectomies are performed each year now in the United States, usually as treatment for Rasmussen's encephalitis and forms of epilepsy that destroy the cortex but do not cross the groove separating left and right hemispheres. Patients can live because neither the disease nor the operation touches areas that control basic functions: the

cerebellum, which coordinates movement; the diencephalon, which facilitates emotions and regulates body functions; and the brain stem, which maintains breathing, heart rate, and other life-support systems.

1943: Jean Paul Sartre, "Being and Nothingness."

1946: ENIAC and the von Neumann "Architecture for Computing."

1947: Lord Nelson, hero of Trafalgar, lost his right arm in battle. He took the present sensation that the arm was still there as "direct evidence for the existence of the soul."

1949: Gilbert Ryle, "The Concepts of the Mind." In his experimental work, Gibson dispensed with the use of two-dimensional, static images and instead explored the perception of motion in freely moving subjects under natural conditions. He published his results in *The Perception of the Visual World* (1950). He went on to develop what he called an ecological theory of perception in *Senses Considered as Perceptual Systems* (1966).

1950: Alan M. Turing published "Computer Machinery and Intelligence" in the philosophical journal Mind. That article gave us the Turing test. Turing outlines the Turing test in terms of an analogous party game: In the machine game, the question is whether you can differentiate a woman from a man pretending to be a woman when both are behind a door and providing written answers to written questions.

Turing made a prediction: "I believe that in fifty years time, it will be possible to program computers to play the imitation game so well that an average interrogator will not have more than 70% chance of making the right identification in five minutes of questioning."

1950-1961: Aldous Huxley, author of *Brave New World,* noted humankind's emergent manipulation of its basic biology in the 1950s and warned in 1961, "For heaven's sake be careful." The need for care is particularly acute as researchers discover the physical basis for what may define us most as humans, our emotions. "Single photon emission computed tomography (SPECT)," developed in the 1950s and 1960s, uses radioactive tracers to visualize the circulation and volume of blood in the brain.

Mid 20th Century: Behaviorism was prominent in both a philosophical and psychological guise. Robotic development increased dramatically. It focused in particular on contemporary robots, emphasizing both the promise they may offer and the threat they may pose.

Empiricism was a dominant theory well into the century. Empiricist theory has two important parts: The first part relates to the theory's fundamental entities, sense data. The fact that perception can be cognitively loaded has been influential in 20th century philosophy of science. If we take the statement far enough, it appears to threaten the very idea of scientific objectivity.

Binet's test was brought to America and renamed the Sanford-Binet test.

1953: James D. Watson and Francis Crick discovered the molecular structure of DNA; Ludwig Wittgenstein, Philosophical Investigations.

1956: Dartmouth Artificial Intelligence Conference. The next major step in AI story was the "Dartmouth Artificial Intelligence Conference," which brought together many of those who would be instrumental in the development of the field. The participants at the Dartmouth Conference had two different goals and favored to different approaches.

1957: There are three types of cones in the retina, each of which uses a different pigment to respond to a different wavelength of light: long, medium, and short. Ganglion cells: They respond to differential input from the three kinds of cones in their receptive areas.

1958-1962: Frank Rosenblatt developed the perceptron, a feed-forward neural network consisting of two connected layers: inputs and outputs. For any pattern a perceptron could instantiate, Rosenblatt's learning rule could train it to that pattern.

The side rule uses the principle of logarithms to mechanize calculation. The slide rule was used up to the 1960's. Such data played a role in Arthur Jensen's work on race and intelligence in the late 1960's and in Richard Herrnstein and Charles Murray's The Bell Curve: the Reshaping of American Life by Difference in Intelligence.

1962: Tomas S. Kuhn, "The Structure of Scientific Revolutions."

Francis Crick, who along with two colleagues won the 1962 Nobel Prize in medicine for deciphering the DNA code that defines genes, says that "You, your joys and your sorrows, your memories and your ambitions, your sense of personal identity and free will, are in fact no more than the behavior of a vast assembly of nerve cells."

1965: Hubert Dreyfus fist attacked the idea of artificial intelligence in the abusive report "Alchemy and AI," developed under the auspices of the Rand Corporation.

1967: Hilary Putnam, "The nature of Mental States."

1969: Marvin Minsky and Seymour Papert attacked neural nets, showing that perceptron could not instantiate certain patterns, such as exclusive or. Minsky and Papert convinced the field that Connectionism could not succeed. Grants for research on neural nets dried up.

1970: Since Gordon Gallup's work in mirrors, it has become the standard test for sense of self. If an animal sees a mark on the forehead of its reflection, will it reach for its own forehead t further explore the mark?

Computed tomography (CT), also known as CT scans, developed in the early 1970s. This imaging method X-rays the brain from many different angles, feeding the information into a computer that produces a series of cross-sectional images. CT is particularly useful for diagnosing blood clots and brain tumors.

Positron emission tomography (PET), developed in the mid-1970s, uses computed tomography to visualize radioactive tracers (*see* Isotopic Tracer), radioactive substances introduced into the brain intravenously or by inhalation. PET can measure such brain functions as cerebral metabolism, blood flow and volume, oxygen use, and the formation of neurotransmitters.

1972: Dreyfus' attack was further developed in later books: What Computers Can't Do and What Computers Still Can't Do. At the core of his attack is a list of four challenges. Humans show "fringe consciousness," a latent awareness of things in the background to which we can shift attention when needed. That shift is something computers can't do.

The cutaneous rabbit illusion was first described in 1972 by psychologists Frank Geldard and Carl Sherrick, who were then at Princeton University's Cutaneous Communications Laboratory. Geldard and Sherrick discovered the phenomenon by accident, while designing experiments to investigate the perception mechanical stimuli applied to the forearm.

1974: Thomas Nagel: "What It is Like to Be a Bat?"

1979: J.J. Gibson, "The Ecological Approach to Visual Perception."

1980: John Searle, "Minds, Brains, and Computers."

1980's: Benjamin Libet (University of California at San Francisco) and his team timed both subjects and objective events in simple voluntary movement.

Magnetic resonance imaging (MRI), introduced in the early 1980s, beams high-frequency radio waves into the brain in a highly magnetized field that causes the protons that form the nuclei of hydrogen atoms in the brain to reemit the radio waves. The reemitted radio waves are analyzed by computer to create thin cross-sectional images of the brain. MRI provides the most detailed images of the brain and is safer than imaging methods that use X rays.

1981: Paul Churchland, "Eliminate Materialism and Propositional Attitudes."

In 1981, because of the volitional prong, the jury found Hinckley "not guilty by virtue of insanity." As a reaction to that decision, the second criterion has largely been abandoned; insanity is once again treated as a matter of what one knows.

1982: Frank Jackson introduces black and white Mary in "Epiphenomenal Qualia." Benjamin Libet's experiments on the timing of readiness potential in the brain and conscious of Willing.

1983: American psychologist Howard Gardner proposed a theory that sought to broaden the traditional definition of intelligence. He felt that the concept of intelligence, as it had been defined by mental tests, did not capture all of the ways humans can excel. Gardner argued that we do not have one underlying general intelligence, but instead have multiple intelligences, each part of an independent system in the brain.

1987: The resurrection of neural tests in Rumelhart and McClelland's "Parallel Distributed Processing."

1988: Daniel Dennett, "Quining Qualia," Hans Moravec, Mind Children: The Future of Human And Robot Intelligence.

1989: Roger Penrose, "The Emperor's New Mind," Colin McGinn, "Can We Solve the Mind Body Problem?"

1990: David Rosenthal, "A Theory of Consciousness."

A Difference engine was built from the Babbage's plans and is now on display in the London Science Museum.

Gardner added naturalist intelligence, exemplified by Charles Darwin. Some have proposed adding emotional intelligence. The theory has clear educational implications. Gardner's vision is of an educational system that recognizes and cultivates multiple intelligences.

Scientists discovered many characteristics of stem cells. Perhaps most interesting, various investigators showed that even mature stem cells from one tissue—the blood, for example—can create cells of another tissue type, such as *neurons* (nerve cells) for the brain. In some of the most exciting results, researcher Fred Gage at the Salk Institute for Biological Studies showed that the brains of adult humans can create new neurons. Before Gage's discovery, neurobiologists assumed that our brain did not create any new cells after birth.

Gardner added an eighth intelligence to his theory: *naturalist intelligence*, the ability to recognize and classify plants, animals, and minerals.

1991: Rodney Brooks, “Intelligence Without Representation;” Institution Loebner Prize.

1994: Francis Crick, “The Astonishing Hypothesis.”

1995: Patricia Smith Churchland, Neuro-philosophy; Paul Churchland, “The Engine of Reason, The Sea of the Soul,” David Chalmers, “Facing up to the Hard Problem of Consciousness.”

1996: Penrose and Hammer off’s “Quantum Theory of Consciousness.”

The Food and Drug Administration (FDA) approved the drug tissue plasminogen activator (t-PA) for use in treating ischemic strokes. The drug is a thrombolytic agent—or clot buster—that can break up blood clots and thereby restore flow through the obstructed blood vessel when administered within the first three hours of a stroke. This small window of effectiveness makes it more critical than ever for patients to seek immediate medical attention when stroke like symptoms develop.

1997: IBM’s “Deep Blue” wins against chess grandmaster Gary Kasparov. Does that show that Deep Blue was smarter? The system could evaluate 200 million positions per second. Perhaps the amazing thing is not that deep Blue could match human play but that a human with far interior calculation and memory could match it.

1998: Andy Clark and David Chalmers, “The Extended Mind.”

Scientific understanding of the brain was dramatically changed in late 1998 when two independent discoveries revealed that brain cells can regenerate and that the fetal human brain contains master cells, known as neural stem cells, which can grow into any type of brain cell. Previously, scientists believed human brain cells could never regenerate themselves, although earlier studies of rodents, fish, reptiles, and birds had demonstrated that brain cell regeneration occurred in these animals.

2000: The date in which Alan M. Turing predicted in 1950 that a machine would pass the Turing Test.

2001: Technology gone wrong is a continuing theme in such movies as West-world, 2001: A Space Odyssey, and the first movies of the Terminator series.

2003: The Human Genome Project also helped shed new light on the brain. When it was completed in 2003, scientists realized that about half of the estimated 20,000 to 25,000 genes that make up human beings are devoted to the development, function, and structure of the brain.

Medical researchers also continue to investigate the effect of stress on the human brain and its influence on the human immune system. For example, stressful events can activate the sympathetic division of the autonomic nervous system and divert blood from the internal organs and skin to the brain and muscles. The stress response also affects the hypothalamus and the pituitary gland, which regulate hormones, particularly the stress hormone cortisol. A better understanding of the brain-body connection may help medical researchers devise treatments for stress-related disorders.

2040: The date by which Ray Kurzweil predicts the "common singularity," in which our machines will surpass us in intelligence.

Part III - Glossary of Terms - Philosophy of Mind

Addiction transference: The phenomenon of replacing an addition to one substance or action with an addiction to another substance or action, usually while attempting to cure the addiction to the first.

Affordances: A concept developed in the work of J.J. Gibson, affordances are possibilities for action in an environment.

Agnosia: Often the result of brain damage, agnosia is a general term for deficits in a person's ability to interpret information from the senses, despite a lack of damage to the senses themselves. See object blindness, prospagnosia, and visual agnosia.

Amass: To gather for oneself, collect as one's own, as to amass a huge amount of money.

Analytical behaviorism: The view that mental states can be analyzed or defined in terms of behavior or behavioral dispositions.

Analytical engine: Charles Babbage drew up the plans for this general purpose computing machine in the mid 1800's; though never built, the device was to be powered by steam and would have used programs on punched cards.

Ancestral: Pertaining to ancestors, descending or claimed from ancestors, an ancestral home, serving as a forerunner, prototype, or inspiration.

Anhydrous ammonia: To make your own anhydrous ammonia you will need air, natural gas and steam. The natural gas reacts with the steam over a catalyst, producing a...see more.

Animism: To describe the theory that the soul is the vital principle responsible for organic development.

Anthropometry: Measure the physical attributes of people.

Antikythera machine: Discovered just off the Coast of the Greek island of Antikythera, the Antikythera machine was a Greek calculating device from about 100 B.C. that could have been used to predict the movement of the sun, moon, and major planets.

Antinomies: Sets of compelling arguments on both sides of an irresolvable issue. In his "Critique of Pure Reason," Kant presents the free will and determinism debate as antimony.

Apocryphal: Of doubtful authorship or authenticity, Ecclesiastical, (initial capital letter) of or pertaining to the Apocrypha, of doubtful sanction, uneconomical, false, spurious. *He told an apocryphal story about the sword, but the truth was later revealed.*

Artificial Intelligence: The science of making machines do things that would require intelligence if done by people.

Asimov's Laws of Robotics: The robots featured in the fiction of writer Isaac Asimov must follow three laws: They cannot intentionally injure human beings, they must obey humans (when this does not conflict with the previous law), and they must protect themselves (again, when this does not conflict with the previous laws).

Automata: Machines built to look like and imitate life forms, people or animals with the appearance of autonomous action.

Axiomatic systems: Systems of axioms of first principles from which other claims can be derived as theorems.

Axon: Neurons, the cells of nerves, are equipped with a long protuberance called an axon. The signal of a neuron travels down the axon and is transmitted to other cells.

Back propagation of errors: A training process in which artificial neural nets (computer instantiated structures loosely based on networks of neurons in the brain) learn from their mistakes.

Behaviorism: In psychology, a research program that seeks to understand the human mind in terms of behavioral inputs and outputs, that is, how humans react to different stimuli and changes in their environment.

Binding problem: The binding problem refers to the question of how our brains assemble data from different aspects of perception into the unified consciousness that we experience.

Blind-sight: Despite their claim to be totally blind, some victims of major damage to the visual cortex are nonetheless able to “guess” about visual information in their environment with amazing accuracy. Paul Humphreys speculates that blind-sight functions by means of visual processing through an older and subconscious route.

Body schema: Used by some researchers to indicate aspects of body image that are unconscious and through which one acts.

Boolean function: Any various functions, familiar from truth tables that take truth values as input and give truth values as output.

Brain state: A particular configuration of brain activities at a given moment. The term is often sued in discussion regarding the philosophy of mind when considering whether mental states, such as belief or love, could reduce to physiological brain states.

Broach: An elongated, tapered, serrated cutting tool for shaping and enlarging holes, a spit for roasting meat, a gimlet for tapping casks, (in a lock), a pin receiving the barrel of a key.

Architecture: An octagonal spire rising directly from a tower without any intervening feature.

Masonry: A pointed tool for the rough dressing of stone, to enlarge and finish with a broach, to mention or suggest for the first time as to broach a subject, to draw (beer, liquor, etc.), as by tapping, to broach beer from a keg, to tap or pierce.

Broca’s and Wernicke’s areas: Two parts o the brain associated with speech functions. Broca’s area is involved with the production of speech. Wernicke’s area is involved with the comprehension of words uttered by others.

Ceteris paribus: A Latin phrase that translates to mean "other things being equal." It is the assumption that other factors are kept constant while investigating a particular relationship.

C-fibers: A category of slower conducting nerve fibers responsible for less specific and slower moving sensations, including pain.

Cartesian doubt: In his effort to determine whether there was anything of which he could be absolutely certain, Rene Descartes subjected all his knowledge to systematic doubt, rejecting anything about which he might possibly be mistaken or deceived. Descartes concluded that only the fact that he is doubting or thinking is beyond all doubt and, from that conclusion, deduces that he exists. Descartes’ cogito, ergo sum-“I think therefore I am” becomes the foundation of his system.

Cognition: A general term for processes of conceptualizing, perceiving, and knowing.

Cognitive psychology: In contrast to Behaviorism, a research program that attempts to understand the human mind in terms of the relation of inner mental states.

Color circle, wheel, and solid: The color circle portrays colors in terms of similarities and oppositions. The color wheel adds a parameter of saturation, with the colors at the edges fully saturated and progressively mixed as one goes toward the center. The color solid is 3-D portrayal that adds the parameter of intensity or brightness.

Compatibility strategy: In the context of the determinism argument, the strategy of challenging the assumption that free will and determinism are necessary opposites. The Compatibilist holds that free will, when properly understood, will be seen to the natural of a casual universe.

Cones: Located in the retina, cones are one of the two types of light receptive cells, rods and cones. Cone cells function in situations of normal light and register color. Different types of cones, using different pigments, specialize in different ranges of light wavelength.

Connectionism: An interdisciplinary movement that attempts to explain the mind in terms of a large number of simple international units, based on the fact that the brain is composed of an interconnected system of neurons.

Copernican theory: Nicolas Copernicus' heliocentric theory in which the planets revolve around the sun.

Corpus callosum: The structure connecting the right and left hemispheres of the human brain that allows information to pass between the two.

Craniometry: The measurement of head shape and size; the attempt to measure intelligence by measure of the size of the brains.

Creature consciousness: As outlined by David Rosenthal, creature consciousness is contrasted with state consciousness and transitive consciousness as the state of a creature being awake or aware. Contrast state consciousness and transitive consciousness.

Cutaneous: Of, pertaining to, or affecting the skin.

De-feasible reasoning: A form of logic in which default assumptions operate until reversed o qualified by new information.

Deflationist response: A response that "deflates" a concept of consciousness of freedom, for example, by showing that an opponent's assumptions regarding the concept are overinflated.

Dendrites: Parts of neurons, dendrites serve as the receptors to the signals relayed by other neurons.

Determinism: In one sense, the claim that every event in the universe is the product of earlier events in accord with natural laws. In another sense, the claim that can be no "free will" because all events are the product of earlier events.

Dialectic: Only tests opinions for their logical consistency.

Difference engine: A machine designed by Charles Babbage in the mid 1800's to calculate and print logarithm tables. Although not completed in his lifetime, Babbage's Difference Engine #2 was finally built in the 1990's by the London Science Museum.

Dishevel: To throw into disorder or disarray.

Dispositional properties: Properties (such as soluble or solid) that reflect what would happen in certain circumstances. In Analytical or Philosophical Behaviorism, mental concepts are said to be synonymous with behavioral properties, generally understood as dispositional.

Distinctiveness: It is another principle that determines the effectiveness of retrieval cues.

Dualism: In classical form, the position that the universe is composed of two radically different substances, mental and the physical. For Descartes, the mental does not occupy as much space as the physical does.

Echolocation: A process of determining distance through the use of sound, used by such animals as bats and dolphins.

Egregious: Notably bad, flagrant.

Engram: To refer to the physical change in the nervous system that occurs as a result of experience.

Echoic memory: The name applied to the same phenomenon in the auditory domain; the brief mental echo that persists after information has been heard.

Encoding: Refers to the initial perception and registration of information.

Engram: To refer to the physical change in the nervous system that occurs as a result of experience.

Einsteinian physics: Einstein theory of relativity (general and special) challenged Newtonian tenets, holding, for example, that matter and energy are interchangeable, time moves at a rate relative to one's rate of speed, and space itself can be cured by gravity.

Empirical: Driving from experience of the world; scientific is a rough synonym.

Empiricist theory: The theory that perception is a process of inference from sense data. Classical Empiricists include Locke, Berkeley, and Hume, but the influence of Empiricism extended well into the 20th century in both philosophy and psychology.

Epiphenomenalism: The view that the mind does not have physical effects but merely "floats above" the physical processes of the brain.

Episodic memory: Refers to memories of specific episodes in one's life and is what most people think of as memory. Episodic memories are connected with a specific time and place.

Epistemology: The field of philosophy devoted to the study of knowledge and how we come to know things.

Ethics: The field of philosophy that focuses on moral issues: ethically good actions, ethically right actions, rights, and obligations.

Eugenics: Selective breeding as proposed human improvement, the proposed improvement of the human species by encouraging or permitting reproduction of only those people with genetic characteristics judged desirable. It has been regarded with disfavor since the Nazi period. The attempt to advance humanity is by the selective breeding of human beings.

Evolutionary theory: In biology, the theory advanced by Charles Darwin that explains the development and complexity of specie through the process of natural selection.

Existentialism: An influential movement in philosophy that took human freedom and one's capacity to create meaning for oneself as starting points.

Explicit memory: It refers to the deliberate, conscious recollection of facts and past experiences.

Faculty psychology: An approach to the human mind in terms of a limited number of powers or capacities.

Flashbulb memory: It is an unusually vivid memory of an especially emotional or dramatic past event.

Forgetting: It is defined as the loss of information over time.

Frame problem: An issue of relevance, the frame problem is artificial intelligence and in understanding human cognition is the problem of deciding what old information should be considered of revision in light of new information.

Free will: The question of whether human beings should be considered to have free will, that is, whether they should be understood to have autonomous control over their own actions, is central to the history of philosophy. Answers given also bear on issues of moral and legal responsibility.

Frontal lobe: The foremost portion of the brain, understood to be an area important for planning and decision making.

Functionalism: The position that mental states are functional states of an organism. Mental states, according to the Functionalist, take environmental input and other mental states as input, with behavior and other mental states as outputs.

Ganglion cells: Visual cells that receive information from the retina and transport it to the brain. The long axon of these cells constitutes the optic nerve.

Glaciations: To subject to glacial action; to produce glacial effects.

Gödel Incompleteness theorem: Kurt Gödel proved that any axiomatic system adequate for simple arithmetic, if consistent, will be incapable of proving some truth expressible in the system.

GOFAI: Short for "Good old fashion artificial intelligence," an attempt to produce artificial intelligence using ruled governed programs of symbol manipulation. Contrast to Connectionism.

Grimacing: A facial expression of disgust or disapproval

Halting problem: In the work of Alan M Turing, the problem of deciding for any given program whether that program will "halt" as opposed to going into an infinite loop.

Higher order thought (HOT): The theories attempt to analyze consciousness in terms of mental states that are about other mental states.

Hippocampus: A seahorse shaped apart of the brain important in the procedures of processing emotions and producing memories.

Hodgepodge: Heterogeneous mixture, jumble; conglomeration.

Holistic view (of the mind): The position that the phenomenon of mind is not the result of a specific region of the brain or a single process but emerges from the function of the brain as a unified whole.

Homunculus: The "little man inside." In philosophical discussions of the "inner theater," the image of homunculus is used to denigrate theories that would explain outer perception in terms of some form of inner perception in brain structure. The term sensory homunculus is used to designate a model of the human body in which the proportional sizes of parts of the model correspond to proportional areas of representation in the sensor motor cortex.

Iconic memory: Refers to the usually brief visual persistence of information as it is being interpreted by the visual system.

Idealism: Sometimes called Subjective Idealism, the response to the mind body problem that holds that the physical world is illusion and only the mental realm exists.

Imbued: To permeate or influence as if by dyeing; to tinge or dye deeply.

Immutable: Unchanging or unchangeable, not changing or not able to be changed

Inference: In logic, the derivation of a conclusion from information contained in the premises.

Inhibitory neurons: In contrast to the more common excitatory neurons, these nerve cells inhibit the firing of their target neuron, instructing it not to fire.

Innate: Present form birth, relating to qualities that a person or animal is born with, forming an integral part of something, Botany joined to filament by base describes an anther that is joined to the filament by its base only, Biology originating within thallus forming an integral part of the thallus of an organism such as an alga or liverwort.

Inner theater: In the philosophy of mind, the inner theater is used to designate an inner realm in which representation of the world is presented.

Instantiate: To represent by a concrete example.

Intelligence Quotient (IQ): The standard way of scoring intelligence tests. In classical form, a person's mental age (the age for which a person's test score is typical) was divided by her chronological age in years, with the results multiply by 100. The average IQ is 100 by definition, with scores for the general population forming a normal or bell curve.

Internationalist of perception: A theory emphasizing that perception is always "perception of" (Brentano), that perception comes with content, rather than content having to be added by inference. Contrast to the Empiricist theory.

Interaction problem: If the mental and the physical are two radically different realms, as Dualism claims, how could they possibly interact? This is the interaction problem posed for Dualism.

Inverted lens experiment: A form of psychological experiment in which a subject's visual stimuli are inverted or reversed by lens. Results show that subjects accommodate to the reversal over time, though debate remains as to whether this is due to an inner perception that "flips" to accommodate or simply because they learn to work in terms of the new patterns of stimulation.

Inverted spectrum: A thought experiment in which one person's color sensations are exactly opposite to anothers; one person's qualitative sensations is blue where another person's is yellow, for example.

Korsakoff's psychosis: A disorder that produces severe and often permanent amnesia.

Kurzweil's "coming singularity": Author and inventor Raymond Rurzweil foresees near future in which our machines will become more intelligent that we are, capable of producing new machines still more intelligent than themselves.

Limbic system: A set of structures deep within the brain involved with emotions and emotional memory.

Loeber Prize: A form of the Turing test run each year, offering $100,000 and a gold medal for the first computer program indistinguishable from a human. See: http://www.loebner.net/Prise/loebner-prize.html.

Logic: The study of patterns of valid deduction. Formal logic represents the essential structure of claims in symbolic form, codifying logical argument in the form of symbolic derivations. Mathematical logic studies formal properties of system of logic. Philosophical logic concentrates on philosophical assumptions crucial to different logical systems.

Materialism: A response to the mind-body problem that holds that only the physical is ultimately real. Reductive Materialism claims that the realm of the mental states somehow, reduces to the physical. Eliminative materialism claims that our concepts for the mental will be eliminated in an ultimately satisfactory and entirely physical scientific theory of human functioning.

Mental age: A controversial concept found in intelligence testing used to indicate the age for which a person's score on the test would be typical.

Mental set or set expectation: In perception, a background of expectations that may influence what is perceived.

Metaphysics: The most general conceptual investigation into the nature of reality.

Mind-body problem: The mind-boy problem refers to cutting our conceptual difficulty in understanding the relation between mental and physical phenomena. For different answers to the problem see Dualism, Epiphenomenalism, Functionalism, Idealism, Materialism, Occasionalism, and Parallelism.

Monism: In the philosophy of mind, the position that there exists only one basic kind of "stuff" or substance. Both Materialism and Idealism are forms of Monism, as opposed to Dualism, which holds that the universe contains two fundamentally different kinds of things: the realms of the mental and the physical.

Monogenism: The belief that races are a single species with a common origin.

Multiple instantiation: The emotion that mental states might be instantiated in any of various forms of organisms and even, perhaps, in machines.

Myopia: Shortness of sight, a common condition in which light entering the eye is focused in front of the retina and distant objects cannot be seen sharply. In high myopia the eyeball is unusually long, whereas in physiological myopia the eyeball length is normal but the power of the cornea is too great for the axial length, lack of foresight, lack of foresight or long-term planning.

Naïve realism: The view that the world as we perceive it is essentially the way the world actually is independent of our perception of it.

NAND: A Boolean connective that means "not both are true."

Neoteny: The prolongation of retention of immature characteristics.

Neural nets: Computational structures instantiated in software but modeled roughly on the operation of neurons in the brain. Trained by back-propagation of errors, neural nets have shown an impressive ability to generalize, that is, to learn patterns applicable to new cases. See also back-propagation of errors, connectionism, and parallel distributed processing.

Neurons: The cells of the nervous system. Simulated by input at their dendrites, neurons pass a signal down their axons to their terminal nodes, where electro-chemicals called neurotransmitters are released into a synapse and stimulate other neurons in turn. See also axon, dendrites, neurotransmitters and synapse.

Newtonian astronomy: Isaac Newton's laws of gravitation codified and explained the movement of celestial bodies in accord with the Copernican (heliocentric) conception of planetary motion. But Newtonian physics also left unsolved a number of problems that paved the way for Einsteinian's physics as a replacement.

Object blindness: A specific type of visual agnosia characterized by the inability to distinguish the identity of objects.

Occasionalism: A form of Dualism, Occasionalism holds that the mental and physical are, in fact, causally isolated but operate in sync through the action o God at every moment.

Optic nerve: The bundle o nerve fibers that brings visual information from the retina (the light sensitive layer on the rear interior surface of the eye) to the brain.

Optical illusion: An image o objects that plays upon human processes, leading a person o misperceive what he or she sees.

Oxymoron: A figure of speech by which a locution produces an incongruous self contradictory effect, as in cruel kindness or to make haste slowly.

Paleontology: Science of dealing with the life of past geologic periods as known from fossil remains

Panpsychism: The doctrine that all objects in the world have an inner or psychological being. A response to the "hard problem of consciousness" defended by David Chalmers and Galen Strawson. The Panpsychist holds that all matter is in some way conscious.

Paradigms: In the philosophy of science of Thomas S. Kuhn, a set of background assumptions and explanatory concepts definite of a science at a particular time.

Parallel distributed processing: A term associated with Connectionist neural networks. It involves systemically constructing networked lines of connections between units, which are strengthened and weakened or failures of the processes.

Parallelism: A form of Dualism asserting that the mental and physical are, in fact, causally isolated but operate in "pre-established harmony" because both realms would up two clocks by God at the inception of the universe.

Perception: The process of gaining awareness of something through one's bodily senses.

Perceptron: A two layer neural net developed by Frank Rosenblatt. Perceptrons could be trained using a simple rule to any logical function they could instantiate, but Minsky and Papert showed that perceptrons could not instantiate some simple logical functions.

Phantom limb: The name for the experience of one who has lost an appendage yet has an illusory sensation of its presence.

Phenomenology: A tradition in philosophy that takes subjective experience as its starting point. Objectivity and science, in this view, are seen as a second level of abstraction; one must use one's experience in attempting to acquire an objective perspective.

Philosophy of Language: The branch of philosophy concerned with understanding how language is structured and uses. Questions arise regarding the relationship between language and reality and how linguistic meaning should be understood.

Philosophy of mind: The branch of philosophy concerned with understanding the nature o the mind, the nature of consciousness, and the relationship between minds and brains, or the mental and the physical. Contemporary philosophy of mind is aggressively interdisciplinary, interfacing with psychology, computer science, and the neurosciences.

Phrenology: The study of the link between head shape and mental abilities. A pseudoscience popular and influential in the 1800s, which studied the bumps of a person's skull to learn about his or her character traits.

Plasticity: Ability to be molded, the condition of being soft and capable of being molded, ability to keep shape after change, the quality that will allow a substance to retain its change in shape after being bent, stretched, or squeezed. Also called neuron-plasticity, brain plasticity, and cortical plasticity, the ability of brain matter to alter so as to perform different functions. In learning new manual skills, areas of the brain may be recruited to new tasks.

Polygenism: Concluded that the various human races did not share a common ancestor and were probably unrelated to one other.

Pre-philosophical facts: Commonsense assumptions or understanding in advance of critical reflection.

Private language argument: Ludwig Wittgenstein's "Philosophical Investigations" is structured as an assortment of separate comments, seen by many as containing a central argument regarding the essentially public nature of language. In these lectures, the argument presented in terms of a necessity for public criteria in language learning and, thus, language comprehension, though there is much disagreement as to precisely what the argument is and how or whether it works.

Privileged access: The notion that we each have access to the contents of our own minds in ways that others do not.

Procedural memory: Refers to the skills that humans possess. Tying shoelaces, riding a bicycle, swimming, and hitting a baseball are examples of procedural memory. Procedural memory is often contrasted with episodic and semantic memory.

Prodigy: Something extraordinary, wonder, a highly talented child.

Prosopagnosia: Often the result of damage to the brain, prosopagnosia, is characterized by the inability to recognize faces, despite being able to recognize other objects without difficulty.

Ptolemaic astronomy: Ptolemy's geocentric (that is earth centered) model of the universe was the dominant theory for hundreds of years, rigorously articulated but eventually superseded by Copernicus's heliocentric model.

Qualia: Essential quality, a property of something, e.g. its feel or appearance, rather than the thing itself, the past tense of quale._Philosophy. a quality, as bitterness, regarded as an independent object, a sense-datum or feeling having a distinctive quality refers to subjective qualitative experiences. For example, the taste of a pineapple or the feel of silk.

Quantum mechanics: Developed in the 20th Century, quantum mechanics is a sophisticated theory regarding subatomic events. Although the theory is well confirmed experimentally, its interpretation remains an area of controversy. Its implications or claimed implications extend to whether Determinism is true, whether every event has a cause, whether conscious measurement is constitutive of the universe, and even what the nature of human freedom might be.

Quantum randomness: In standard interpretations of quantum mechanics, events occur at the quantum level that have no specific cause and are impossible to predict.

Rapprochement: The establishment of or state of having cordial relations

Reductive materialism: That form of Materialism that holds that the mental can be reduced to the physical. In terms of the relation between the things at issue, Reductive Materialism claims that mental things are ultimate purely physical. In terms of sciences at issue, Reductive Materialism claims that the science of the mental will follow directly from the science of the physical.

Relation properties: A property something has in virtue of its relation or interaction with another thing. "Beside" and "married" are relational properties. One thing cannot be "beside" all by itself, nor can a person be "married" without another person. Relational properties are contrasted with intrinsic properties, which belong to something independent of their relation to others.

Retina: The layer of light sensitive cells that covers the rear interior of the eye. The retina registers light as the beginning of a process of signals sent to the brain.

Retrieval: Refers to the processes involved in using stored information.

Retrieval cue: Any stimulus that helps us recall information in long-term memory.

Robotics: The study and design of robots, machines that work somewhat autonomously to perform tasks for humans.

Rods: Located on the retina, rods are one of the two types of light reception cells, rods and cones. They function in situations of little light and do not register color.

Saccades: Our eyes move in swift jumps called saccades (saccadic motion) as we scan across something, such as the page of a book or a computer screen.

Savant: Person of profound or extensive learning; learned scholar.

Scythe: An implement for mowing by hand (as grass or grain).

Semantic memory: Refers to our general knowledge of the world and all of the facts we know. Semantic memory allows a person to know that the chemical symbol for salt is NaCl, that dogs have four legs, that Thomas Jefferson was president of the United States, that 3×3 equals 9, and thousands of other facts.

Semantics: The meaning of the symbols of a system of language or the study thereof. Semantics is contrasted with syntax, a matter of the shapes of the symbols and rules in terms of those shapes. Semantics concerns the relation of those shapes to ideas and things in the world.

Sense data: In the Empiricist theory, information delivered o the brain via the senses that is then used as the basis for the inferences that form our experience of the world.

Sensory cortex: The part of the cortex that registers touch from various parts of the body; the sensory cortex is organized in a way that corresponds roughly to the organization of the body.

Shrapnel: Bomb, mine or shell fragments.

Solipsism: Belief in self as only reality. The belief that the only thing somebody can be sure of is that he or she exists, and that true knowledge of anything else is impossible. The position that the only thing that exists is in one's own mind.

Spandrels: In Evolutionary theory, properties or organisms that were not directly selected for but nonetheless "came along for the ride."

Split brain patients: People in whom the corpus callosum between the two hemispheres of the brain has been surgically cut, often to relieve extreme epilepsy. Split brain patients function normally in most contexts but show surprising behavior in carefully constructed experimental conditions because of the lack of communication between the hemispheres.

State consciousness: In the work of David Rosenthal, the sense in which a mental state is conscious. For example, belief is a conscious belief or anger is a conscious anger. Contrast creature consciousness and transitive consciousness.

Storage: The retention of encoded information over time.

Strong AI: Also known as the Cartesian Dualism, the position that the universe is composed of two radically different kinds of "stuff" or substances, the realm of the mental and the physical.

Syllogisms: Pairs of propositions that, taken together, give a new conclusion.

Symbol processing: The methodical manipulation of symbols. A calculator does math by manipulating symbols according to rules, for example, rather than by adding with the quantities the numbers may represent.

Synapse: In sending a signal to another neuron, the neuron ejects neurotransmitters into the small space between the two neurons. That space is called a synapse.

Syntax: The structure of the symbols in a language or the study thereof. Syntax is a matter of the shapes of the symbols and rules in terms of those shapes. Semantics, in contrast, concerns the relation of those shapes to ideas and things in the world.

Transitive consciousness: In the work of David Rosenthal, transitive consciousness is consciousness of something. Contrast creature consciousness and state consciousness.

Trichromacy: The normal human capacity to see colors. The term refers to the fact that color perception functions in terms of three sets of color-sensitive cones in our retinas.

Turing machine: An abstract machine conceptualized by Alan M. Turing as a formal model for the concept of computation. The Turing machine served as a model for the building of real computers.

Turing test: Alan M. Turing suggested that the question "Can a machine think?" be replaced with a specific test. In communication through a monitor interface, can a computer fool a person into thinking that it too is a person.

Unity of consciousness: Despite receiving a variety of sensory data, processed in various areas in the brain, we experience consciousness as a seamless unity.

Valid: An argument is valid if the conclusion follows the premises. A deductively valid argument is one in which the connection is logically tight an in which it is logically impossible for the premises to be the true and the conclusion to be false.

Visual agnosia: A form of agnosia that results in an inability to interpret visual data. Both object blindness and prosopagnosia fall under this subcategory.

Visual cortex: Usually used to refer to the primary visual cortex located in the rear of the brain, which processes incoming visual data from the eyes.

Volitional (or willing) dysfunction: A disorder that inhibits a person's ability to control his or her own actions.

Voluntary action: An act made as a result of one's choice, contrasted with voluntary or reflex actions over which one does not have conscious control.

Von Neumann architecture: An overall design for computers presented by John von Neumann in 1945 on the basis of work on the ENIAC. Virtually all contemporary computers have von Neumann architecture, in which memory functions to contain both data and the program ht operate on those data.

Waft: To cause to move or go lightly by or as if by the impulse or wind or waves.

Weak AI: Weak AI is a research program in which programs are used to understand mental states. Strong AI, in contrast, is the claim that an appropriate program would a mental state.

Zombies; in thought experiments in the philosophy of mind, zombies are supposed to behaviorally and functionally identical to people but without consciousness or inner experience.

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