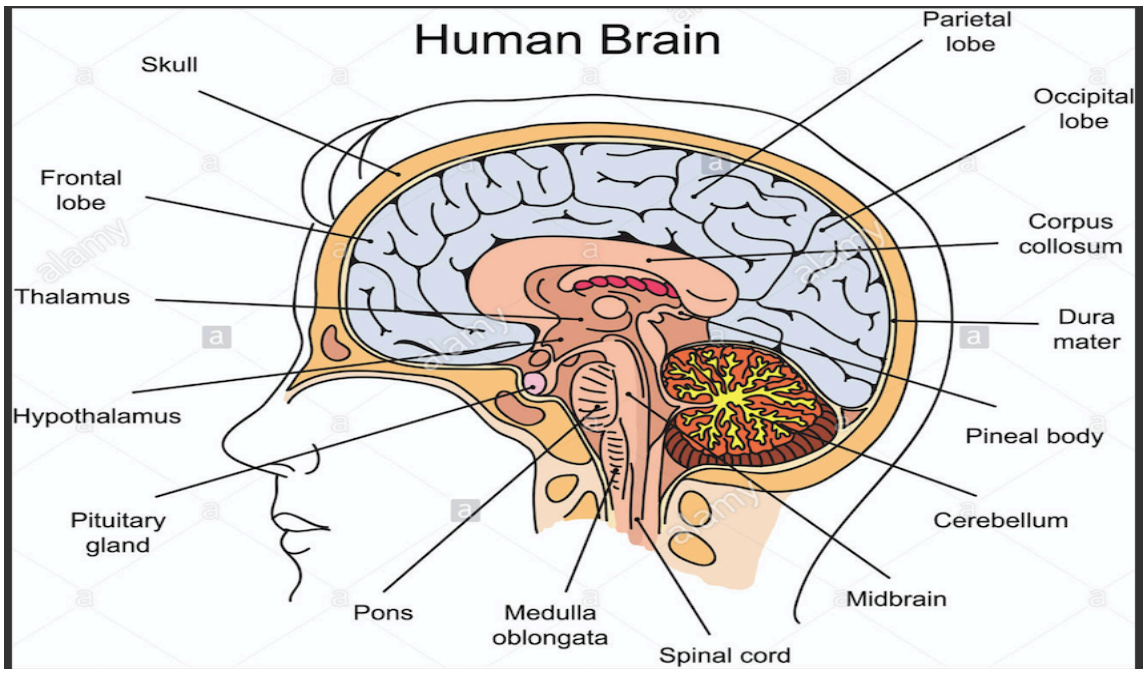
Cognition and cognitive Process Modeling:

Theory Assignment 1

Quesion. What are the different parts of the human brain? Mark them in the different cross sections in the brain and mention their work.

Answer: The human brain is the centre of the central nervous system in humans as well as the primary control centre for the peripheral nervous system. The brain controls several activities of human body, such as heart beat, respiration and digestions. These are known as autonomic function of brain. Human brain also controls thought process and reasoning, these are known as higher order conscious activities.
Just like a sensor, the brain receives signals from sensory organs and outputs the information to the muscles. The structure of human brain is same as any other mammals but the size of human brain is comparatively larger in relation to body size of any other brains. Human brain consist of nearly 100 billions of neurons.

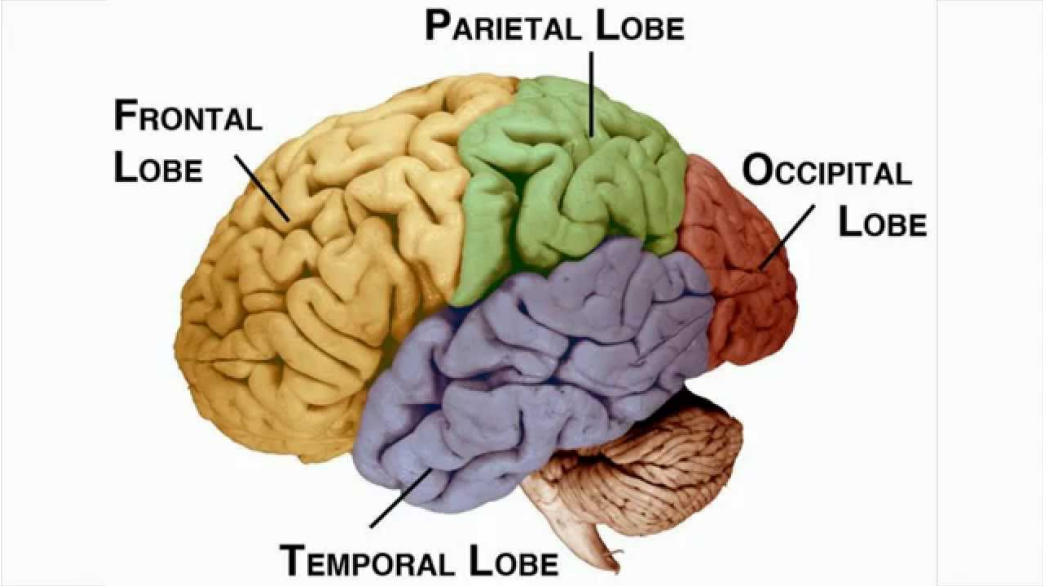


Structure of brain

The human brain mainly has three parts i.e **Cerebrum**, **Cerebellum** and **Brainstem**.

1. **Cerebrum :** It is largest part of human brain. Cerebrum also accounts for two third of total brain weight. Cerebrum is divided into two hemispheres. Underneath the cerebrum, there is brain stem and behind the cerebrum, there is cerebellum. It is responsible for memory, speech, the senses and emotional response. One hemisphere usually the left one is functionally dominant and controls the language and speech while the other hemisphere interprets the visual and spatial information. The left hemisphere and right hemisphere is connected by a neuron called Corpus Collosum. Each hemisphere controls the opposite side of the body parts i.e if something happened in left side of the human body, then there might be some problem with the right side of the brain and vice versa. The outer most layer of the cerebrum is known as cerebral

cortex, which consist of four lobes: the frontal lobe, parietal lobe, temporal and occipital lobe.



a) **Frontal lobe:** It is largest of all the lobes and as the name indicates, frontal lobe is located in the front of the human brain. It manages the important cognitive skills of human brain like problem solving skills, emotional activities, sexual behaviours etc. It works like our control panel. It is also responsible for controlling out motor systems. As it controls several cognitive skills, any damage in frontal lobe may result into change in personality and behaviour.
b) **Parietal lobe:** The parietal lobe lies in between frontal and occipital lobe and above the temporal lobe. It is responsible for processing the information. It takes signals from vision, and information such as touch, taste and temperature are processed. We will not be able to feel the touch sensation if there is any damage in parietal lobe.
c) **Temporal lobe:** It lies in the middle of the each brain's hemisphere. It is responsible for memory storage, visual recognition, face recognition and the recognition of languages. Any damage in temporal lobe may cause visual disorders.
d) **Occipital lobe:** This lobe is responsible for controlling the vision and visual processing. It helps us identifying the different objects and it is also responsible for identifying different colours. Occipital lobe starts functioning as soon as a baby is born and as the infant grows, the vision becomes more acute and the ability to understand the images also increases.

2. **Cerebellum:** It is located beneath the cerebrum and above the brainstem. It is responsible for controlling the motor functions i.e it controls the physical activities like how we walk, run or talk. In addition to this cerebellum is also responsible for motor learning. i.e when an infant grows, he/she learns to walk. The cerebellum stores the important information in order to progressively develop the walking procedures.

3. **BrainStem:** It controls the flow of information between brain and the body. It is also responsible for basic body functioning such as breathing, heart rate, swallowing etc. Brainstem has 3 components: **Medulla oblongata, midbrain and pons** .

a) **Medulla oblongata:** It is the lower part of brain stem, and is connected with the spinal cord of our body, while the upper part of the medulla oblongata is connected with the pons. The medulla contains the cardiac, respiratory, vomiting, and motor centers regulating heart rate, breathing, and blood pressure.

b) **Mid Brain**: It is related with vision, hearing, motor control , sleep and awake cycles, alertness and temperature.

c) **Pons :** The Pons lies between medulla oblongata and mid brain. It is responsible for flowing messages from cerebrum to the medulla and to the cerebellum.

Cortex : The surface of the cerebrum is called the cortex. It has a folded structure with hills and valleys. Each fold is called a gyrus, and each valley between folds is called a sulcus. Messages can travel from one gyrus to another, from one lobe to another, from one side of the brain to the other, and to structures deep in the brain. The cortex contains 16 billion neurons that are arranged in specific layers. Our conscious thoughts and actions takes place in the cortex.

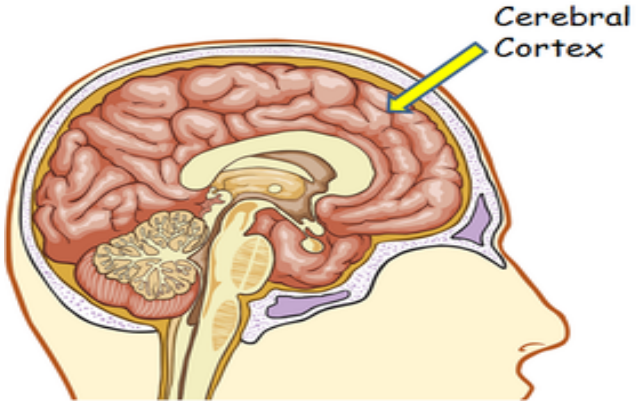


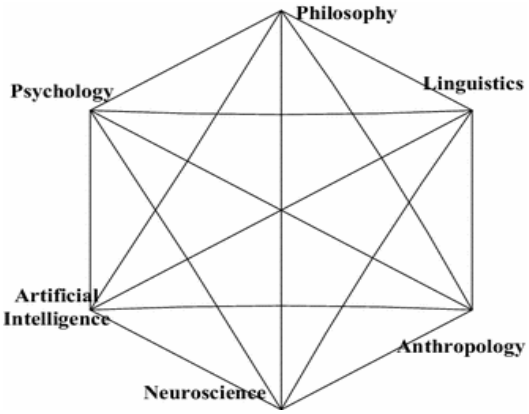
fig. Brain Cortex

Thalamus: The thalamus is a small structure within the brain located just above the brain stem between the cerebral cortex and the midbrain. It plays a role in pain sensation, attention, alertness and memory. It has an important function in directing sensory input to the appropriate place in the cerebral cortex.

Hypothalamus: It controls certain metabolic processes and other activities of the Autonomic Nervous System. It plays a role in controlling behaviours such as hunger, thirst, sleep, and sexual response. It also regulates body temperature, blood pressure, emotions, and secretion of hormones. It controls of daily cycles in physiological state and behaviour.

Question: How these approaches explain the human cognition? Please provide detailed answer with examples.

Answer: The figure below shows the different approaches of cognition. There are mainly five approaches of cognition: Philosophical approach, psychological approach, linguistics approach, biological/Neuroscience approach and artificial intelligence approach.



Philosophical approach : This approach questions about generality and normativity. This means that philosophy may contribute to the study of cognition because of it's strange commitment to generality and normativity. Generality talks about general questions about multiple areas of investigation. The proper role of philosophy in cognitive science can be illuminated by considering various analogies that philosophers have used to characterize their enterprise. Many philosophers such as Descartes have thought that philosophy ought to provide foundations for knowledge, which would require it to be prior to science:

Psychological approach: This approach talks about psychology behind the cognition. It follows the analytical approach which studies the mind and it's phenomena. Cognitive psychology was originated in late 50's. This approach tries to make functional model of minds which can further be used for studying human behaviour. This approach talks about brain mind relationships. Initially, Psychological approach was meant to be a part of biological approach and philosophical approach but Psychology then set out to establish itself as an independent discipline for studying the operations of the human mind, using the experimental method and the principles of psychophysics.

Biological Approach: Biological approach is also known as neuroscience approach. It is more focused towards studying the connections and behaviours of neurons or group of neurons. Instead of trying new things, this approach is biased towards studying the existing things and make a model to do the same task which is performed by neurons. The basic aim of this approach is to understand the nature and structure of our mental operations. It follows computational analysis approach which is a logical process aimed at determining what properties a given system must have in order to execute a given behaviour. Biologists can provide insights about the brain and other physical aspects underlying cognition. Cognitive psychologists and cognitive neuroscientists pursue the same goal: to understand how the cognitive system functions. But psychologists studies mental events independently of the brain just the way information-processing operations executed by a computer can be studied without considering the physical characteristics of the machine whereas, cognitive neuroscience approach follows the idea that cognitive activities are what the brain does, so describing mental processes requires data about the brain.

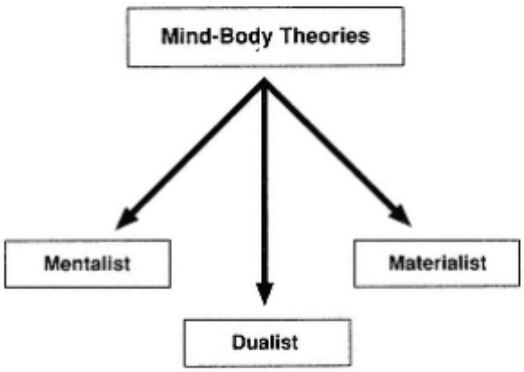
Artificial Intelligence approach: This approach talks more about simulation of brain basically the functionality of brain and possible ways to mimic it on a computer. The aim of AI approach is reasoning, knowledge, planning, learning, Natural language processing, perception and the ability to move and manipulate the objects. This approach includes statistical methods, computational methods, machine learning. The term "artificial intelligence" is applied when a machine has the same "cognitive" properties that humans associate with other human minds,

such as “learning” , “problem solving” etc. This approach is about the theory and development of computer systems able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages.

Linguistic approach: This approach is based on combined knowledge of psychology and linguistics. It talks about how languages interacts with cognition, how languages makes our thoughts. Cognitive linguistics deals more with language in general than with particular natural languages at most, it studies only the standard usage of a small number of natural languages. It describes how language interacts with cognition, how language forms our thoughts, and the evolution of language parallel with the change in the common mindset across time. The cognitive commitment aim is to characterize the general principles of used language that are consistent with what is known about brain anatomy and functions from other sciences.

Question 3: How these theories are able to explain the relation between mind and body? Also, draw a contrast between all three theories with the help of examples.

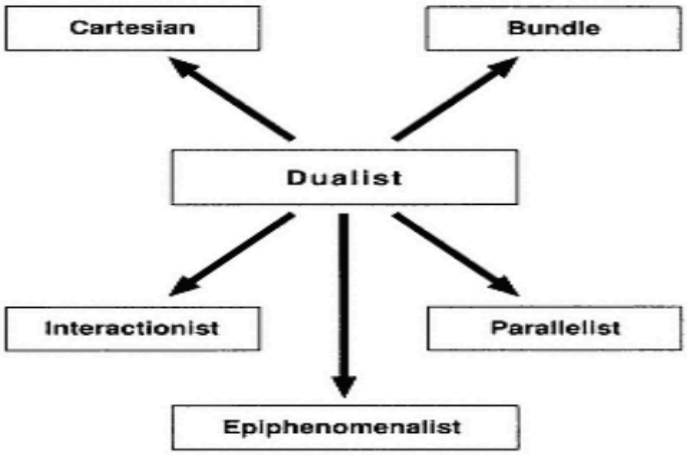
Answer: The diagram below shows the different approaches of mind body theory. There are mainly three proposed theories: Dualist Theory, Mentalist Theory and Materialist theory.



Mentalist Theory: This theory says that mind is everything i.e mind is a spiritual substance and body is just the feeling of mind. Mentalist theory basically follows three major religions views about Mind body theory. Hinduism, Buddhism and Taoism all the people following this believes in the existence of mind. That it is all about Mind. Physical existence is just an illusion. There are few general features of mental states listed below.

a) Some mental states are caused by states of the world.
b) Some mental states cause actions
c) Some mental states cause other mental states
d) Some mental states are conscious
e) Some kinds of mental states are systematically correlated with certain kinds of brain states.
f) Some mental states are about things in the world

Dualist Theory: Dualist theories tells that mind and body both are substances. The body consist of extended or material substances i.e it occupies space. While mind in unextened or spiritual i.e it does not takes any space. As per the dualist theory mind and body are completely different substances. The figure below shows the branching of Dualist view.



Cartesian Duality : It depicts that mind and body are substances. Body is physical and extended while the mind is spiritual and unextended.

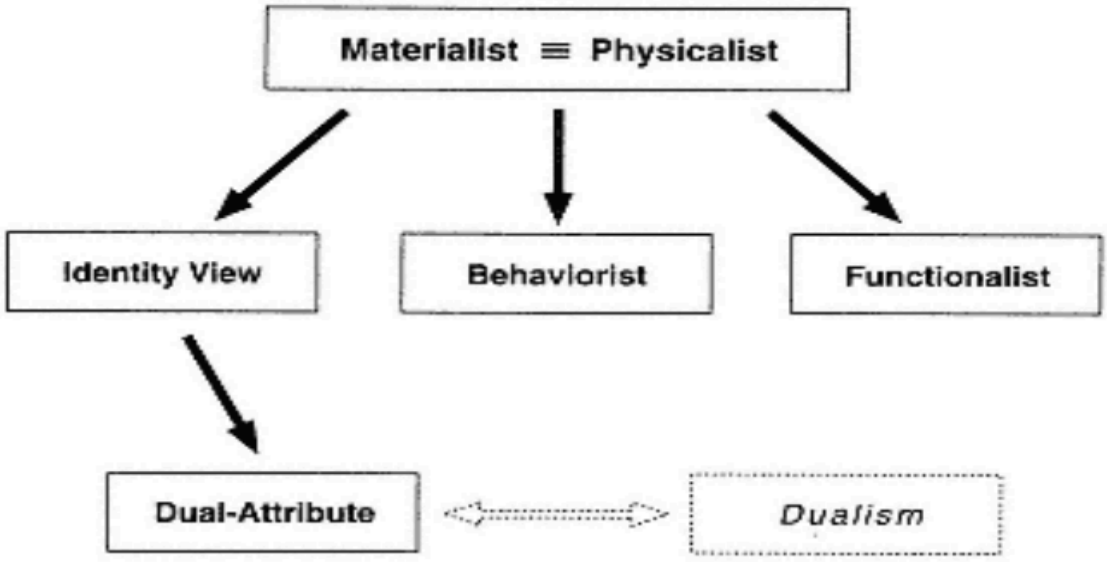
Bundle Theory : This theory says the mind if nothing butn only bundles of perceptions. That's the bundle theory, partitioning the mind into bundles while leaving the physical world intact.

Interactive Duality: This theory says that mind and body both interacts with each other i.e mind affects the body and body affects the mind.

Parallel Duality: This theory talks about parallelism i.e mind and body both works in parallel, but mind has nothing to do with body. It says that mind and body are independent to each other.

Epiphenomenalist Duality: This theory says that the body affects the mind but not conversely. i.e our experience is epiphenomenal everything we do will happen in same way even if we didn't have the subjective experience.

Materialist Theory : This theory says that mind is just a physical process. The figure below shows the branching of materialist theory.



Behaviorist view : This view says that mind is nothing more than sophisticated behaviour.

Identity view : It defines mental events with physical processes in nervous system. There is only one substance i.e physical but mental happenings are allowed to interact with physical body.

Functionalist view : This view says that minds are simply what brains do. It is like a software Hardware system. Brain is a hardware and mind is a software running on it. Hence researchers in artificial intelligence are more biased toward the functional view.

Dual Attribute view : It says that brain has both physical as well as non-physical properties. Both physical and mental processes resides inside the nervous system. But they are the same. Brain processes have certain properties that are called physical, and others that are called mental.

References:

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4. **https://en.wikipedia.org/wiki/Cognitive_science**