Understanding the Mind

The cognitive revolution led formulation of a theory of mental activities but comparing mental activities with computer programs are not very correct. The hardware that runs these programs (mental activities vs. computer programs) are made up of different materials. Also computer OS can run on several machines in the same way, but the same is not true for mental activities

Mind and Brain

It is not wholly correct to state the mind and brain as comparable to hardware and computer programs. Some times repetitive programs are converted into electrical circuits (hardware) which perform the same functions as software program but the same cannot be done with brain and mind.

The true distinction between brain and mind can only be understood by examining it through various **levels of analysis**. For e.g., Computer can both be described in terms of its physics (electrical circuits) and OS (software). Similarly for decoding any mental process we need information about its functions as well as the structures that lead to this process. For e.g., Emotions

Mental Representations

All mental activities are about something – a job choice, a friends face, thoughts about your summer holidays etc. Cognitive psychologists try to understand how information is stored is internally represented.

a representation is a physical state (marks on page, neural connection in the brain, magnetic fields in computers) that conveys information specifying an object, event or category or its characteristics. They have 2 important facets –

(a) form – *the format of conveying information*

(b) content – *the meaning conveyed by the representation*

Mental Processing

In order to understand how representations work we need to understand the process that operate on them.

a process is transformation of information that obeys well defined principles to produce a specific output when given a specific input.

Several processes combine together to produce a processing system to accomplish a task

Why study the Brain

If mental representations and mental processes are the key to understand human behavior why study the brain. The interest in brain studies has developed for two main reasons

(a) Identifiability – refers to the ability to specify the correct combinations of representations and processes used to accomplish a task. In reality this concept suffers from the structure-process tradeoffs

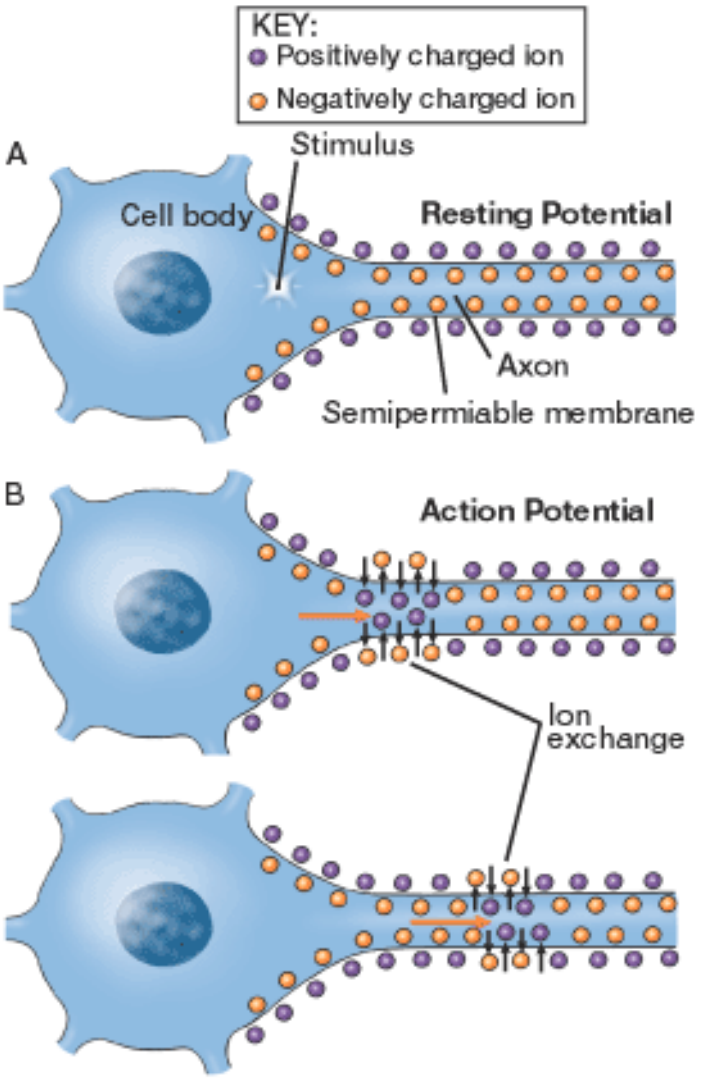
(b) Adequacy – facts about the brain can help us test adequacies of mental processes which helps us know whether a process is valid in most situations

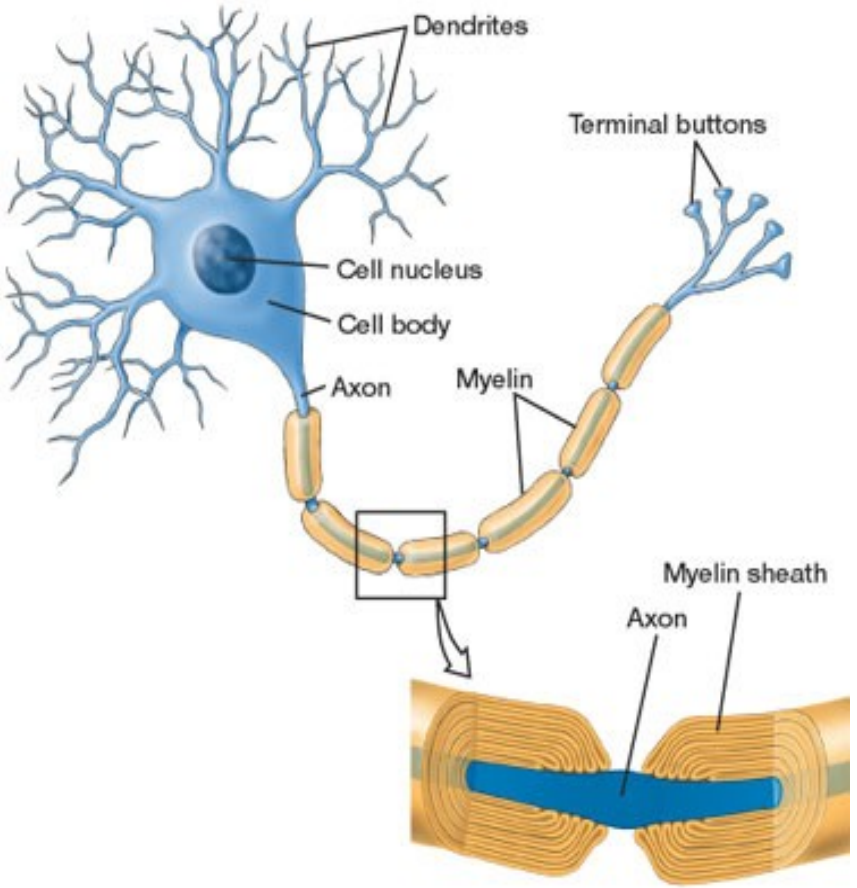
The Cognitive Brain

In order to study the brain we need to understand the structure of the brain. The primary building block of the brain is the Neuron. Neurons are to brain as bricks and mortars are to architecture of a building . Neurons are of three types

(a) Sensory
(b) Motor
(c) Interneuron

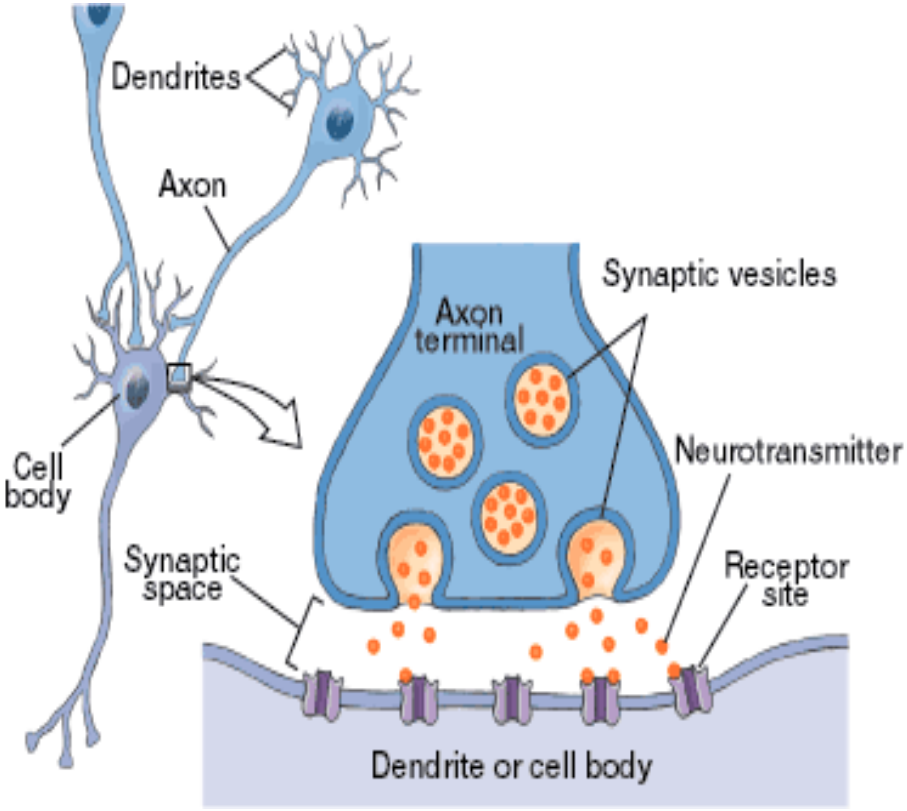
Physical Structure of the Neuron

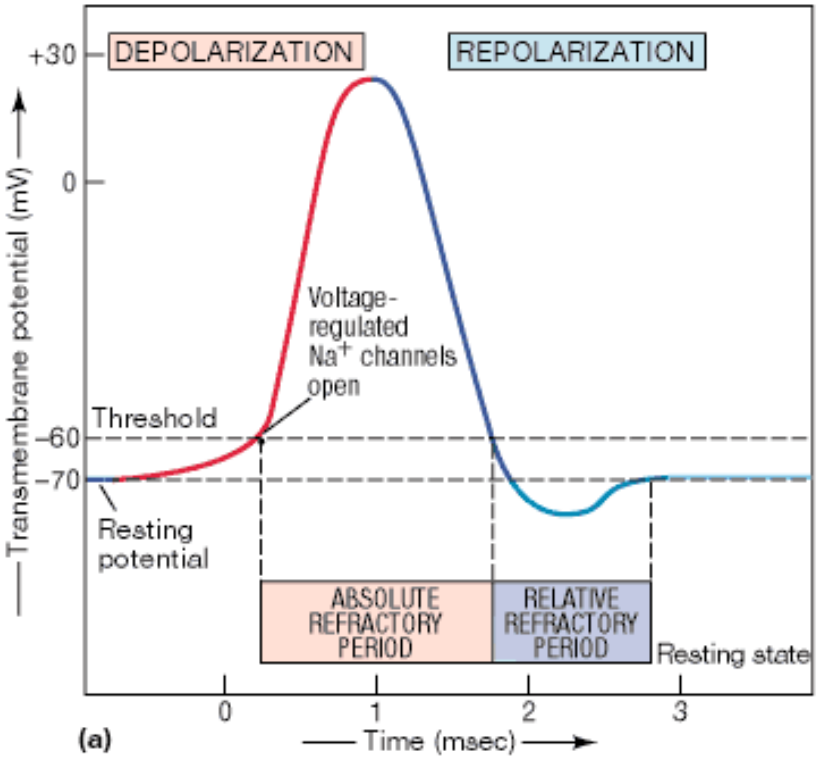




Neuronal Transmission

Electrical Changes in Neuronal Transmission

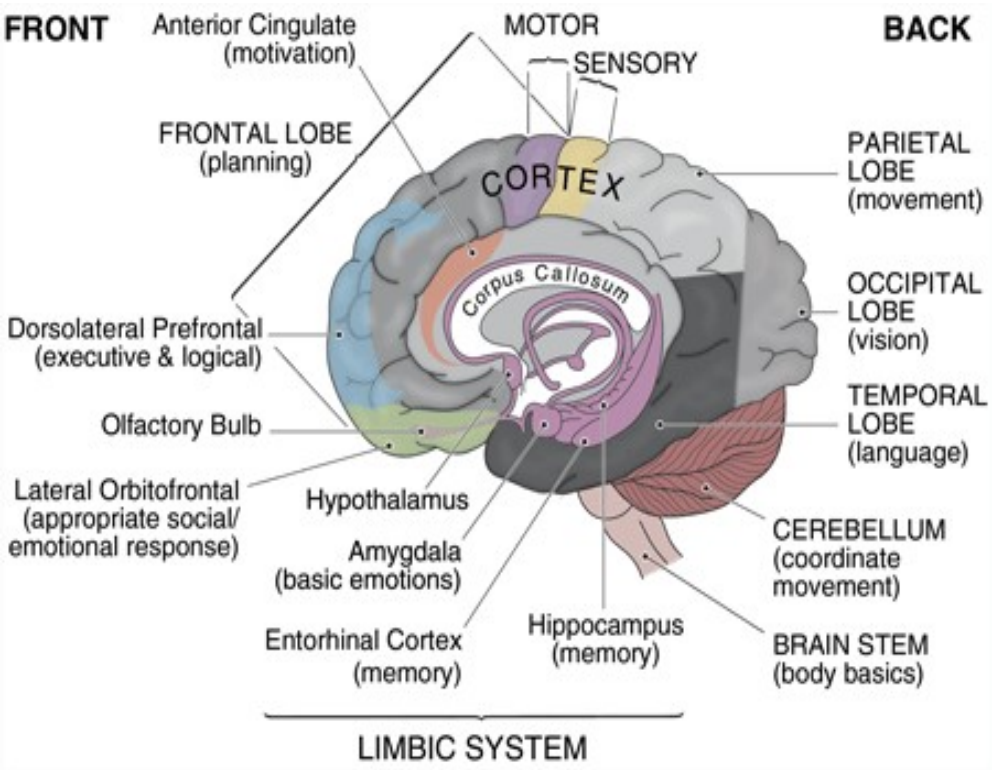




Synaptic Transmission

The Structure of Nervous System

- Nervous system
  - Central Nervous System
    - Brain System
    - Spinal Cord
  - Peripheral Nervous System
    - Skeletal System (Striated muscles)
    - Autonomic System (Smooth Muscles)
      - Sympathetic Nervous System
      - Parasympathetic Nervous System



Studying Cognition

a) Behavioral Methods

Methods / Measures	Example	Advantages	Limitations
Accuracy (% true / false)	Memory Recall (such as remembering requirements of a job	Objective measure of effectiveness	Ceiling / Floor effects (speed – accuracy trade off)
Response Time	Time to answer a specific question	Objective and subtle measure of processing including unconscious processing	Experimental expectancy effects also speed – accuracy tradeoffs
Judgments	Rating on a seven point scale (e.g. how successful you see yourself in performing a task)	Can access subjective reactions. Easy and inexpensive to collect	Participant maybe unaware of using the scale, may not be honest
Protocol collection (speaking aloud one's thoughts about a problem)	Taking through the pros and cons of various job possibilities	Can reveal a sequence of processing steps	Cannot be used for most cognitive processes that occur unconsciously or within seconds

b) **Co-relational Neural Methods**

Method	**Example**	**Spatial Resolution**	**Temporal Resolution**	**Invasiveness**	**Cost**
EEG / ERP	Track stages of sleep / Brain response to novelty	Poor (approx 1 inches)	Excellent (approx 1 millisecond)	Low	Low purchase / use cost
MEG	Detect activity in auditory cortex to tones of different pitches	Good (under 1 cm)	Excellent Milliseconds	Low	High purchase / medium use cost
PET	Detect activity in language areas as subject speaks	Good (about 1 cm)	Poor (1 image every 40 seconds)	High	High for both
MRI	Show structures of brain	Best (about 1 mm)	Depends on level of resolution	Low	High
fMRI	Shows activity in brain areas	Best (about 0.5 cm)	Typically several seconds	Low	High
Optical Imaging	Shows activity in brain areas (same as PET)	Poor (at present about 2 cm)	Depends on level of resolution; typically several seconds	Medium	Low

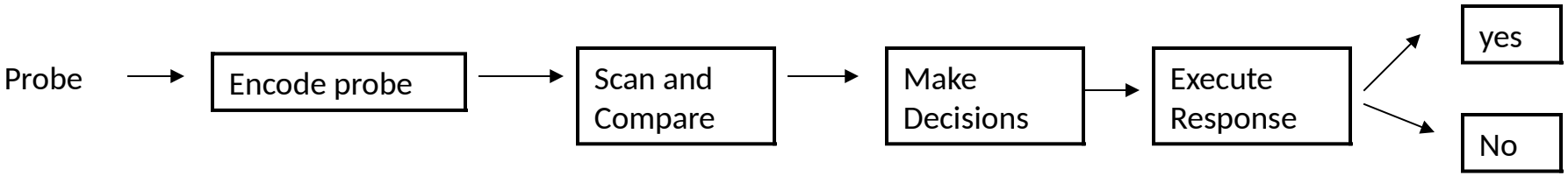
c) Causal Neural Models

Methods	Example	Advantages	Limitations
Neuropsychological studies	Examine deficits in understudying nouns but not verbs	Tests theories of causal role of brain areas; tests theories of shared and distinct processing used in different tasks	Damage is not often limited to one area, patients may have other deficits
TMS	Temporarily disrupts occipital lobe and show that this has the same effects on visual perception and on visual mental imagery	Same as neuropsychological studies but the transient “lesions” is more restricted	Can be used for brain areas near the surface (TMS affects only tissues about 1 inches down)
Drugs that affects specific brain systems	Disrupt the action of noradrenaline, which is crucial for the operation of hippocampus	Can alter the specific brain systems; typically is reversible	Many drugs effects many different brain systems; the temporal resolution may be poor

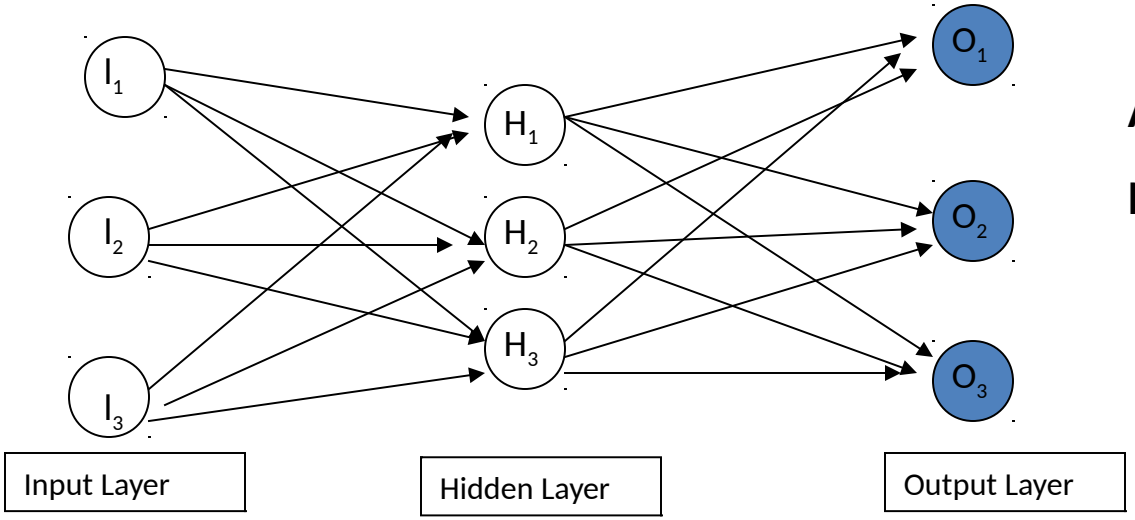
d) Modeling

In psychology models are often implemented as computer programs which are meant to mimic the underlying mental representations and processes that produce specific types of human performance

1) ***Process Models*** *- specify a sequence of processes that convert an input to an output. Such models can be illustrated by using flow charts (for e.g.,)*



2) Neural Network Models – *rely on sets of interconnected units each of which is intended to correspond to a neuron or to a small group of neurons. Units are not same as neuron but rather they specify the input-output process group of neuron perform (for e.g.)*



A Simple Feed-Forward Neural Network Model