The Nature of Psychology
Prof. Naveen Kashyap
Department of Humanities and Social Sciences
Indian Institute of Technology, Guwahati

Lecture – 09
Memory - I

Friends welcome back to this lecture number 9 on the series on Human Behaviour. Now today's topic of discussion would be Human Memory. And what you going to do is we going to see how learning leads to memory and what is the need of memory, what are its functions and why should we be studying memory on a course on human behaviour that is what the next 2 lecture which is lecture number 9 and 10 would be doing. But as usual things that we do before any lecture is recapping what we did in the past lectures.

So, dwelling upon why did we start this course to the course started because I wanted to explain to you what is human behaviour and not only explain what is human behaviour, I also wanted to give you a science or introduced to you to a science of studying human behaviour that was psychology.

So, we looked at in the first two lectures the reasons why do we actually need the science of psychology or why do we needs to study human behaviour. In those lectures we looked at the questions of how the science of human behaviour which is psychology came in and we looked at how philosophy and physiology has its role to play into the study of human behaviour and the nurturing or the upcoming science or psychology. Then we looked at the history of basic questions about human behaviour provoke from the philosophical point of view and from the physiological point of view.

Questions like what is soul, what is mind, what is brain what is consciousness and those kinds of questions and how does psychology answer them because psychology was promised to be a scientific field. So, we looked at how does this science or psychology started and we did little bit of work on to the schools of psychology, early schools of psychology, structuralism, functionalism, behaviourism, gestaltism and psychoanalysis. Then we looked at the newer schools of psychology like cognitive neuroscience and psycholinguistics, neurology or other interdisciplinary sciences which aids the study of human behaviour and aid the study of psychology.

Towards the end of this lecture we looked at how do we do psychological research and we looked at multiple methods not limiting to only experimentation, but also extending to the idea of observation or survey correlation and literature review or single case studies so, methods of doing psychological research. So, the first two chapters were dedicating in introducing the concept. Then once you know what psychology is and what it does we started by looking at how does the human behaviour emanate first of all.

So, for human behaviour to emanate to start you have to respond to in the something in the external environment and this responding to something in the external environment starts by first of all understanding external environment or making a copy of the external environment and understanding it. Now the first step in this process is grabbing the external environment or encoding the external environment in a way that humans understand it and there is the process recession. So, we looked at what is sensation, how does the sensory system works and we look at concepts related to the sensory system.

So, what is sensitivity, what is sensory coding those kind of things and what are absolute threshold, differential threshold, signal detection theory, questions of sensory coding and so on and so forth that is what we looked at. And how these sensory systems grab information from the environment and how it is translated into something which are encoded into something which the brain can understand. Then we took a model system which is the human eye and looked at how this model system encompasses or consists of or functions and encode the sensory physical stimulus into the psychological realm.

Further to that we looked at something called perception which is making interpretation. So, the sensory system encode the physical environment into the psychological realm, but what makes meaning of the sensory stimulus is a process which is called perception. So, perception is organising the sensory stimulus and making and meaning out of it. We looked at why is perception necessary and we looked at multiple theories of perception (Refer Time: 05:04) gestalts view to the Gibson in view and to the interactionist view. So, different views of our perception really functions and then we moved on to something called the 5 steps of perception.

We started by looking at what is attention. So, attentional processes and looking at what is sustained and divided attention; the second step being localising and objecting the external simulation. So, localising an object starts with understand the figure background

and then also looking at monocular and binocular cues and depth perception and things like that. The third step being recognition where we focus on how information is recognised. So, once the sensory systems passes some information on to the perceptual system how does the perception system make meaning, how do they recognise?

And so, there are two steps into it; one is thus the early model and the other is the late model. In the early model basic information is gathered. So, primitive information from the sensory organs are captured together and glued together. In the next step this glued information is compared across a standard, ideal or representation which is already stored and so, the 2 models help you into recognising.

So, the first step is integration, the second step is pattern matching, these 2 steps in recognition. And then we have abstraction and constancy. So, in abstraction what happens is, how does the perceptual system abstract information from the sensory system or abstract information from the sensory system. So, what is abstraction? Abstraction is getting only those information from the bunch of sensory stimulus that the perceptual system receives which is necessary for it to make any identification right.

If I looking at a face you just need the eye the or some specific features of the face because eyes, nose and that kind of thing is already stayed stored into the human memory or the perception system. So, you do not need to store those kind of information and that is how you distinguish person A from B and then we have constancy which is maintaining certain constants right because constancy is necessary for the human brain to make all kind of interpretations.

The last 2 lectures may on learning. So, once you have these information and once you are integrating this information you learn and so, what we looked at is what is learning and learning is a process through which you acquire knowledge and use this knowledge and so, it is a relatively permanent change in behaviour.

So, which basically means that learning can also go backs to no learning stage, it can also proceeds to higher learning state. We looked at the 2 theories of learning which is classical conditioning which says that any behaviour change happens through combining the reward before the behaviour occurs and then some there is something called instrumental conditioning in which once you do the right behaviour you are rewarded and there is a consequence of this you keep on doing the behaviour.

So, we looked at both classical conditioning and instrumental conditioning and parameters for it. The third form of learning that we also did was called observational learning which is basically a form of learning in which the subject copy someone else, a role model and by copying he is acts he when he gets rewarded the person was copying the behaviour also does a similar act according to the model. If the model is not rewarded and he is punished the copying behaviour is decrease and so, that is what the observation learning.

But whatever we learn needs to be safe somewhere and there is where the science of memory comes in that is where the existence of memory comes in. So, that is what memory is all about. So, what is memory basically? It is a store where you keep your information right. So, memory that is what was believed of memory in the first couple of years when memories research started, it was thought of it is a store as a place where you keep on information, but then later on researches or researches believe that is not as simple as that it is not just like almirah where you can store things.

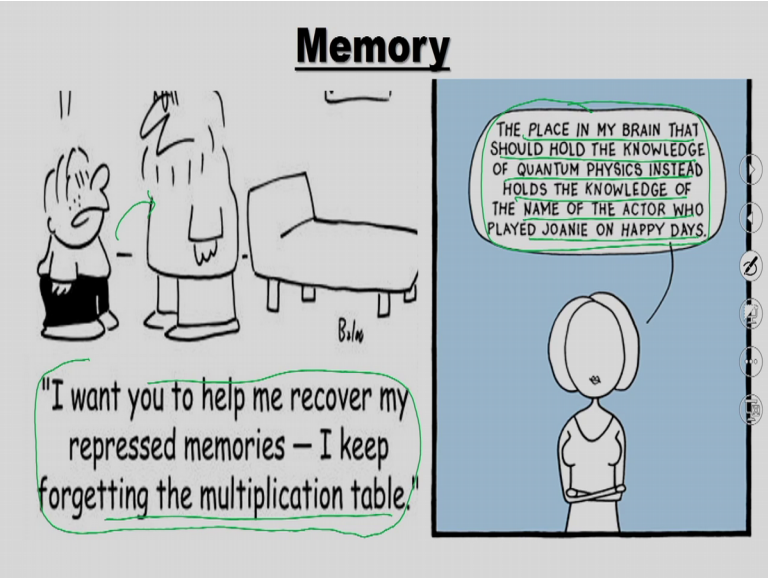
There are 2 more processes to memory which is basically the encoding process of how you feed in information and there is a retrieval process if is that is how you take away information from the store. So, memory we came a now a study of 3 part process. The science of memory started very early on and the first research scientific research in memory happened with the coming of Ebbinghaus, but even before that there was a lot of work on memory. Even during the philosophy state they exist or the days when psychology had not developed and philosophy was the major science which led to all of the sciences coming up.

People were interested in how somebody store something. And so, the conceptualization a memory in those periods on those days where in terms of a cave, in terms of a tablet because it was it was known that sometimes memory also get erased and so, memory was thought of also as a wax tablet where something is written and then it can be erased. Memory was also thought of as a storage a cave where you can store information, it was thought of as a cupboard or almirah where information can be stacked on one over the other. And so, these are the conceptualizations of memory by the early philosophers. And later in the 19th century 1950's around 1950's memory was thought of at as a when telephone was invented it was thought of as a connection of network or connection of

one line to another that is how memory the information processing theory of memory started.

So, what will be doing in this lecture is not only introducing to you what memory is all about we will also look at some theories of memory, some approaches to memory and then we look into the idea of memory in terms of what can be stored what cannot be stored. So, basically then let us start our definition of what is memory.

(Refer Slide Time: 10:53)

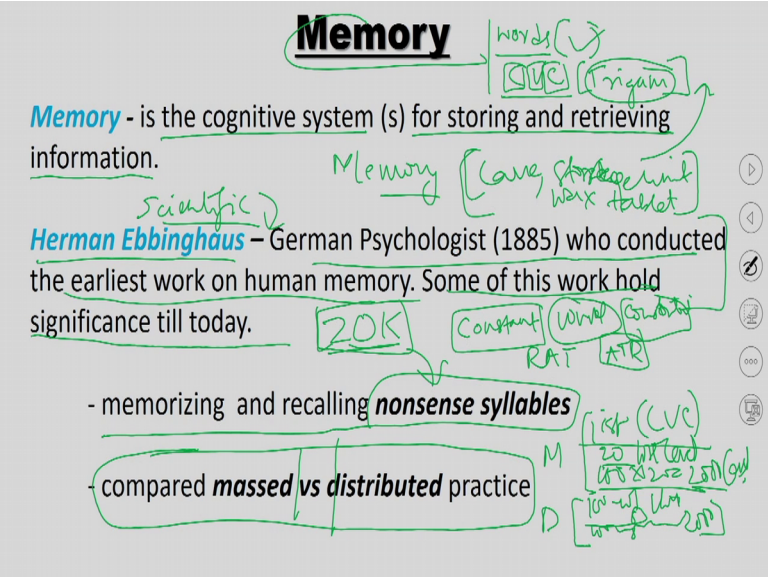


Now, we will start our lecture by looking at 2 interesting cartoons. As you can see in this cartoon how is memory important. He says that I want to help you recover my repressed memories; I keep forgetting the multiplication table.

So, here is a person he once; obviously, psychoanalyst here to recover memories for him. Similarly in the second clip you can see another interesting example of memory the place in my brain that should hold the knowledge of quantum physics instead hold the knowledge of the name of an actor who plays Joanie or Joanie on Happy Days. And so, as you can see these are what the some interpretation of memories. Why it is important? It is important. So, memory is not important to you because you have it. The moment you don't have memory then the problem arises and so, there are several deficits or there are several cases in which people do not have memory.

For example, short time memory you do not remember my after beating someone what this person looks like or what this person is and sometimes you have failures in long term memory where you cannot remember anything from your past anything from your past life. And so, the idea of memory or the existence of memory what the need for memory comes in only when you don't have memory.

(Refer Slide Time: 12:11)



So, let us quickly start up by looking at the definition of what is memory. And so, memory has been explained as a cognitive system for storing and retrieving information.

It is a 2 part system which are not only stores information, but also helps in retrieving information. Now, as I said early days memory was the idea of memory was in terms of it is a cave, it is a storage unit or it was a wax tablet. So, these were the conceptualizations of philosophers or early scientists by the scientific study of memory started with someone called Herman Ebbinghaus. Now he was the German and he took up on himself to establish what was memory or to find out what are the parameters of memory, find out what are the characteristics of memory and so, he had no subject to start with.

So, what he did was he started doing experiments on his own. Now, German psychologist in 1985 Herman Ebbinghaus conducted the earliest work on human memory. Some of this work hold significance today. So, what was he actually doing? He was trying to look at what is human memory and what are the characteristics of it. How

did he do that? He wanted to see for how long people can remember things and what kind of information can people actually remember. So, what he did was he learned list of words.

Now, obviously, if you learn list of words the chances are that you would have use this words before and so, there was no way to establish a baseline, there was no way to establish a minimum threshold or a baseline from where you would start measuring memory. So, if there was no way to establish a 0 memory state right because words are there with you always right. You have a (Refer Time: 14:16) words and so, there is nothing called 0 memory for words. So, what he did was intelligently he created something called the CVC or something called the trigram. Now what is that trigram? A trigram is the arrangement of letters or alphabets in the English language following a CVC technique. What is the CVC technique?

So, you have a constant, a 3 letter word which has a constant at the beginning, a vowel at the middle and a consonant at the end and this word mix no meaning. So, it is a non word. So, if I write RAT this is a word, but if I write ATR it has is not a word, it is an acronym for a kind of flight which is there or if I write something like ZOK it does not make any meaning. So, what this Ebbinghaus did was he constructed words like this with a consonant vowel consonant, but they make no meaning and so, you made multiple list of word like this and started learning those lists.

What you wanted to see is how forgetting happens and what is memory and for how long when we can store some things, what are the characteristic of things that we can store. Now, obviously, if word like this are there, there will always be 0 memory because you are not seen these words right these are constructed words. So, there was a 0 baseline where there to start with you had no memory of it right and when you started learning these words again and again so that he could come up with a state where he could reproduce all the words 3 times without making any errors.

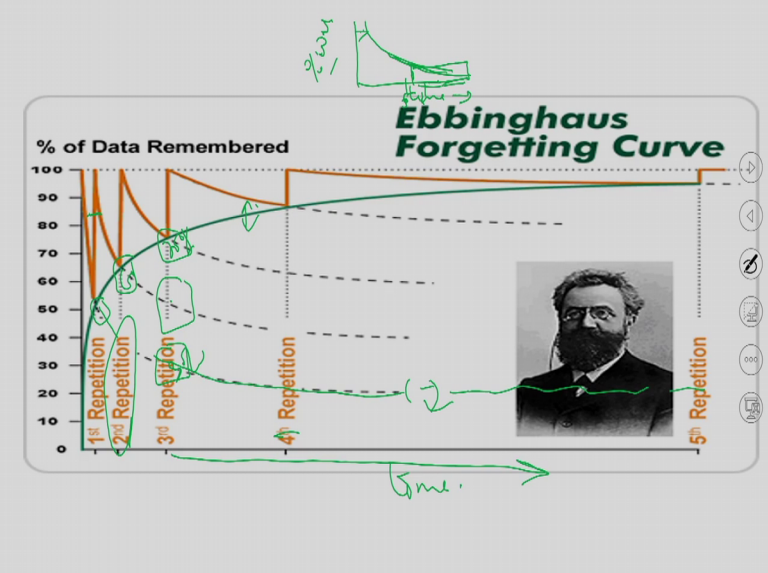
So, started by learning list of these kind of words. So, basically what he did was he was memorizing and recalling nonsense syllables. So, this kind of a CVC things. Now these are the 2 techniques that he used for remembering these words. One was massed and other was distributed practice. So, in massed practice what he did was he took list of CVC words. So, Ebbinghaus took list of CVC words and learn them in one sitting. So,

let 20 lists of CVC word, each list having 100 words. So, we have 100 into 20 which is around 2000 CVC words and he did that in 1 hour maybe that is called massed practice.

In distributed practice what happened is so, in massed practice that is what he did? So, this is mass practice. In distributed practice what he did was the 2000 word who are remember in this way. So, first he remember or first he learn let us say one 100 words, took a break for 5 minutes then again learned one 100 words took a break for 5 minutes and kept on doing it till he learned all the 2000 words. So, in one case he did not take any break that is called the massed practice and learn all the 2000 words which is 20 list with 100 word each in one go.

In the other case he learned one 100 words took a break then learned 100 words and that is called the massed distributed practice.

(Refer Slide Time: 17:53)



This is what Ebbinghaus found out. This is called this particular line is called the forgetting curve and as you can see the, this is the percentage of data remembered and this is the number of repetitions that we have. And what he found out is that initially what happened is that with the number of repetitions he did this was what was forgetting this was how the forgetting was happening.

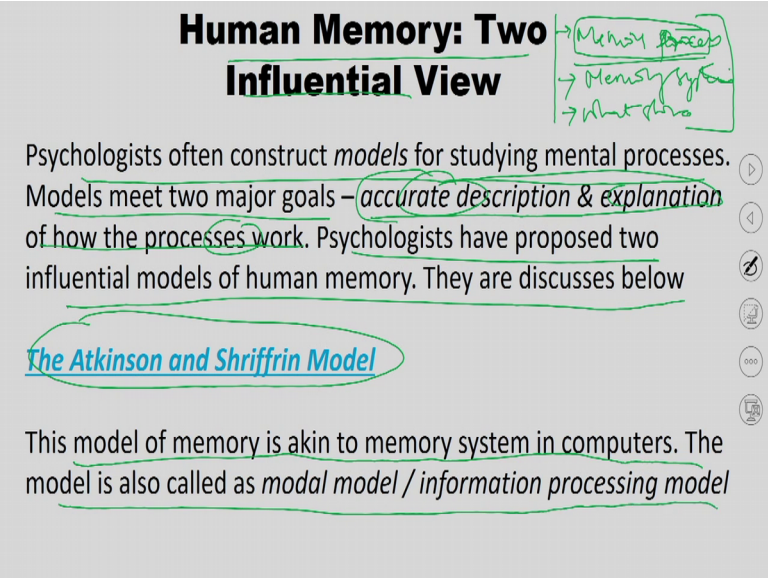
Now, with the first reputation as you can see initially your 100 percent remembrance and then it keeps on falling and the reputation come the number of words that you remember

was falling down to 20 with the fourth repetition and with the fifth repetition it became constant. With the second repetition, the second time that you learn after learning the list and he took a recall of those list as you can see initially the number of words were 50, but after third repetition in this case within the third repetition only 30 percent is remembered in this case in the second case you have 60 percent repetition. So, 50 percent, 60 percent and in the third repetition you have 70 percent that is there.

This is the time axis as time is passing. So, as time passes the number of repetitions goes in this way and so, the percentage of data remembered as you can see follows this curve. So, what happens is what he found out is that Ebbinghaus forgetting curve goes something like this. This you this is my time axis and this is the percentage remembered, initially people remembered a lot of words; percentage of words remembered. And what he found out is that initially people remember a lot of words, but as time passes it follows a asymptote right.

So, after the fifth repetition, after the fifth hour or sixth hour what will happen is the number of words that you remember will be almost the same, area under the curve will be almost same and so, this is what he is understanding is.

(Refer Slide Time: 19:53)



What he found out is that forgetting follows a asymptote after a period of time. So, initially within the first are you remember more number of words then the second hour the number of words will fall sharply, but after the third fourth fifth hour onwards, let us

say after the fifth hour the number of words that you keep on remembering will the same that you remember after 24 hours, 48 hours and then 72 hours and so on and so forth.

So, initially there is the although the number of the words that you remember is very much, but the forgetting will be very high initially. Now human memory, there are 2 influential view of human memory. So, what we are going to do is you going to see how does memory really function. Let me describe a case for you and make you understand what is the need of memory and so, this popular case which happened in the United States. What happened is this person was tortured or not tortured this person who was threatened and some kind of life threatening act was done by a person on this lady.

And so, this lady identified the from when she got over a trauma she identified a person because when then this life threatening act was done on her she remembered a scatter kind of a hairline and so, from a police line up she identified one person, a person by the name of wood I did not remember the story right now, but he under, but she identified a person on the police line of saying that this is the SLA based on the memory that she had while the act of threatening act was performed on her which was the life threatening act.

Now, this person kept on saying that I did not do this act, this lady identified her from the police line up and show he went in for jail and he this person was given a 54 year jail term after serving a lifetime. So, that much time. Now this woman was kept was police captain asking this women are you sure about this because he is getting a very harsh sentence and yes women kept her words saying no this is the person I remember the hair lined and that is what he did and so, this person was jail, Now, in spite of having a very good alibi or a very strong alibi of being somewhere else when the crime was committed the person was convicted to jail.

He was the father of 3 and had wife at home, had a family at home and he was a very good person, but still he was committed to jail just by the incorrect memory of this lady. Years later in the prison itself some other man kept on boasting saying that I did this life threatening act on this lady and nobody caught me and so, when this came to the knowledge of the police they came back to this lady saying that look can you do are identification for us and this lady kept on insisting that the person who was punished or incorrectly punished was the person who committed the act on her.

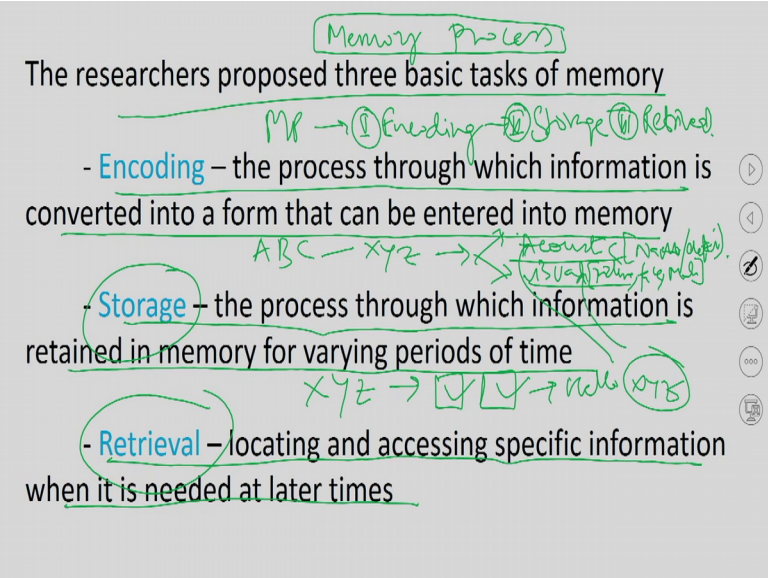
Now that that is what she stick to years later after, 10 years a DNA sampling was done and it was found out that this man was incorrectly put into jail by a simple memory mistake by this woman. So, the DNA evidence suggested some other person who was boasting in the jail that he committed the crime and a person who did not commit the crime actually went into jail and so, that is what so, years after the DNA evidence this person who was incorrectly put into jail was let out and this lady had a shock of her life when she had incorrectly identified.

So, this is what memory is all about. This is how strong memory is and how correct and incorrect it could be. But our study here on memory what will be focusing on 3 things on memory. First something called memory systems, second so, the process of memory, second is memory systems; so, how many types of memory is there and third what is stored in memory. So, this is the outline of this particular lecture. Let us start by looking at the process of memory, what is memory.

So, psychologist often construct model for studying mental processes. Models meet 2 measure goals; one an accurate description and second an explanation of how the processes really work. And the most psychologists when they are looking at mental processes what they do is they construct a kind of a model and what models actually do is this give you some kind of a accurate description of what they are and how the model actually works or how the process actually work.

So, psychologists are proposed 2 influential models of human memory and they have been discussed. So, memory process is what will looking at first how does memory really work and in the context of something called the Atkinson Shiffrin model and the other is a network model. So, what is the Atkinson Shiffrin model all about? This model of memory is akin to memory systems in computers the modal model or the information processing model of memory.

(Refer Slide Time: 25:19)



Now, before we go to the Atkinson Shiffrin model let us look at something called the memory process. What do we call memory and Atkinson Shiffrin model is a model which actually explains this memory process. So, researches propose 3 basic tasks of memory. Any memory task or any memory has 3 basic functions; one is called encoding the process through which information is converted into a form that can be entered into memory then they restores storage the process through which information is retained in memory for varying period of the time and retrieval is a process which is locating and accessing a specific information when it is needed in a later times.

So, memory process has 3 parts; any memory process has 3 parts part. One is called encoding which is storing information. So, encoding is also akin to learning. Then there is a part 2 of any memory which is called storage this is the process of storing information into memory and then there is a third part process which is called retrieval which is accessing what has been stored. Let us take an example and understand what is encoding storage and retrieval. Assume that you met a friend of yours or somebody a stranger was introduced to you by a friend.

So, this friend comes in to you and says hello miss (Refer Time: 26:40) please meet my friend xyz. Now you know this friend of yours who is introducing you to another friend of his or hers and you remember the name, you call this person by the name and so, you are introduced. So, now, you know this friend of a friend who was introduced to in the

morning. Later on the day you don't see your friend, but you see your friends friend and when you meet this person to say hello miss (Refer Time: 27:08) or mister (Refer Time: 27:09) how are you? Now how did you learn this friend name? The process is akin to what memory happens.

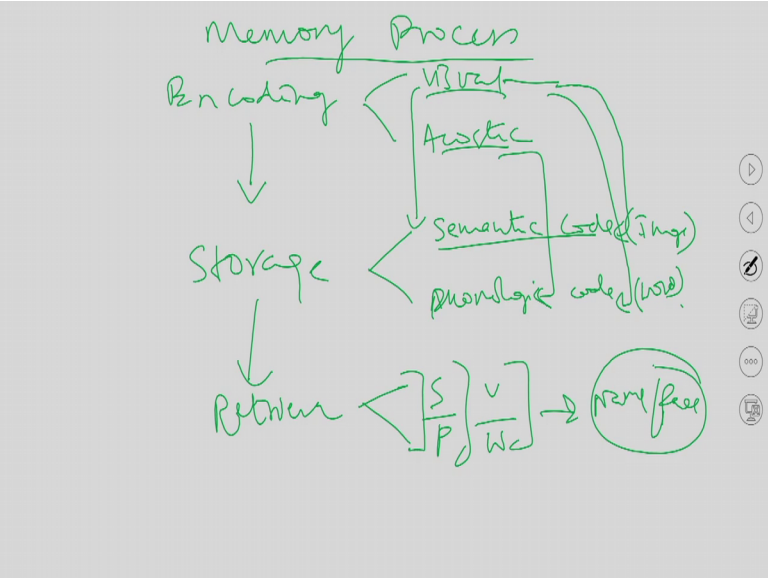
So, when in the morning you met this friends friend who was XYZ and the ABC is your friend. The first step is when ABC introduce XYZ to you this XYZ's name was encoded into your memory. So, you heard 2 forms of it right. So, ABC introduce introduces to you XYZ and when you see XYZ, there are 2 codes there are 2 information which is entering to your sensory system. One is the acoustic and the other is the visual information. Acoustic is the name or any definition or any detail that is spoken to you about the friend's friend.

For example meet XYZ he is from this place or she is from this place she lives here there that kind of information is all acoustic. Visual is the picture or the face or any other marker visual marker of this XYZ that you know. So, the information is encoded through 2 bits, through 2 channels. One is the acoustic channel the other is the visual channel. After meeting this XYZ, you go on your doing your daily work and the name and the details of this person are stored in your memory at 2 distinct places. One is the acoustic store; the other is the visual store. A face memory stored and a name memory stored or some other information memory store.

Later on in the day when you meet this XYZ alone, a process of retrieval happens. When you meet this person immediately 2 processes, the visual memory or the visual storage and the acoustic storage they integrate together and then when you meet this person you say that first you identify the face of this person and then you identify the name of this person and then you say that hello XYZ. So, you are retrieving both information.

The information the acoustic information is retrieved and the visual information is retrieved from where it was stored in the morning and this is how the memory works and this is what the encoding storage and retrieval processes. So, most memories have something called the memory process is encoding now encoding could be in terms of visual, acoustic, the second step in the memory process is something called storage. This is how these visual and acoustic are stored.

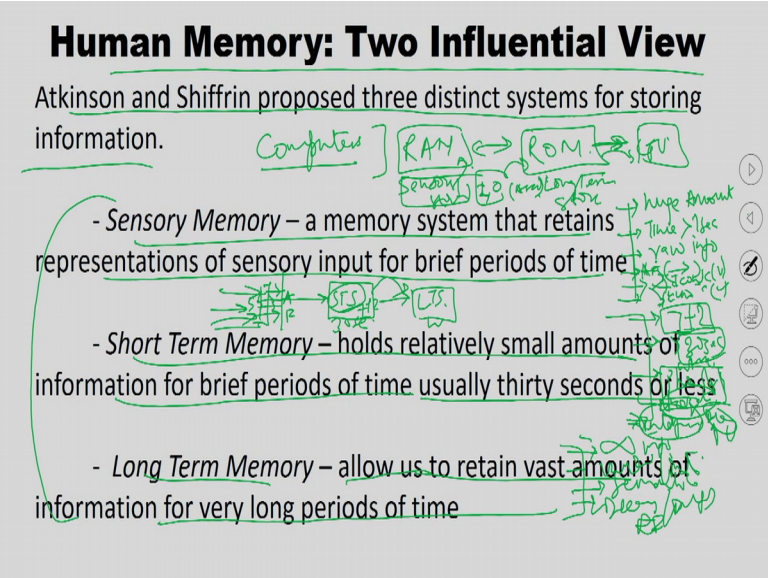
(Refer Slide Time: 29:47)



So, visual memory is stored as semantic code and acoustic information is stored as the phonologic code which means that information in the visual field face memory is stored as a meaning, face memory is stored as a image and this image has a semantic code. So, it is stored as a image and this is stored as a word and so, it follows the phonologic code. And later on when it is retrieved at retrieval both this semantic and phonological code or the visual and the word combined together to form name face relation.

So, you now retrieve the information and retrieve the name and face of this person and you say whatever you say.

(Refer Slide Time: 31:23)



So, let us look at the human memory the 2 models of human memory. The first model is called Atkinson and Shiffrin which was proposed as a 3 distinct system for storing information. Atkinson and Shiffrin's idea of human memory came from the basics of information processing theory and what information processing theory believe that information is stored or retrieved in a 3 sensory system or 3 store system. The first store is called as the sensory store where all information is gathered and depending on filters this information is passed on to a store which is a temporary storage is called the sensory the short term store or temporary stored in terms of information processing theory.

And if information is processed up on it moves on to something called the long term store. Think about human computers. Now, computers have 2 stores; one is called the RAM the random access memory and the other is called the ROM which is the read only memory. Now the RAM is keen into something called the sensory store and the ROM is keen into something called as long term store and it travel processes the processes which happen through the CPU which can push in information.

So, initially when the computer starts it is the RAM which is storing all the information for you. When you input something into the computer is the RAM which holds this information. Later on the processor of the process or the software package in which you are feeding the information that converts whatever you are in putting into in into a code. Now generally the computer has a simple a I 1 and 0 code which is called the unitary

code or the or the binomial code that is how the computer stores. So, if for computers it is easy. So, no matter what you do the processor, the software package will convert all information that you are feeding on to the computer into the 1 and 0 code.

And this one and 0 code is what is actually store into the ROM right or is also called the ASCII if you look at it is called the ASCII code and so, it stores into the ROM. Later on when you open that same package or when you want to retrieve the same information, the ROM passes this code into the software package with again translates back into the information that you actually store.

So, when you type W 1 to the keyboard this W first the information that W typed is passed on an electrical impulse and this electrical impulse is then later on translated by the software package as a 1 and 0 into 1's and 0's which is stored in the ROM. The software package reads this information and displays a W, W on the screen and that is how the information is passed.

Now, keen to this is the idea of human memory which was proposed by Atkinson and Shiffrin. And So, what Atkinson and Shiffrin says is there are 3 types of memory there are 3 types of memory process something called the sensory memory there is something called the short term memory and there is something called the long term memory and there is a distinction between short term memory, sensory memory and long term memory. Atkinson and Shiffrin believes that human memory is a 3 part system. The first part is called the sensory store. What is a sensory store? A sensory store is a store where all information is available, a lot of information is available in the sensory store and it can actually keep an information from all the senses from all kind of sensory information from very very brief period of time.

Depending on the kind of filter that you use or the attention that you use only 1 percent of information or a fraction of information passes from the sensory store to the short term memory. So, what Atkinson and Shiffrin believe is that the human memory is composed of something like this. You have something called the sensory store, this is my sensory store. So, sensory store has a number of information bits which is passing on to it and then I have something called attentional filter. This attentional filter will take in all this information which is coming from the environment and then decide what information to pass.

So, this attentional filter is the buffer which let us you or a sea which let us only 1 bit of information or one called a fraction of information to pass. This information when it is passed it goes to something called a short term store or short term memory and in short term memory information stores for longer durations of time. So, we will look into the idea of short term store sensory store and long term store in a minute and so, here information stores for let us say 30 seconds; say generally it stored for 30 second, but the information that can be stored in the short term store is 7 plus or minus 2 bits of information. Further on if the information is repeated it moves on to something called the long term store and in the long term store the information stores for unlimited period of time depending on the number of repetitions.

So, what is sensory memory? It is a memory system that retains representations of sensory input for very brief period of time. So, what is the speciality of this store? One speciality is that huge information; huge amount of information can be stored here or can be accessed here. What else? The time of storage is less than 1 second. So, for 1 second a lot of information can be stored here. Third we generally have raw information here. Mostly the information which comes to sensory store is raw, it is not coupled in any weight is not encoded in anyway and the fourth part or the fourth characteristic of this store is that we need attentional filter. So, an attensional filter is needed for taking in grabbing information from the sensory store and passing it to the short term store.

And the fifth is that there are 2 or 3 types of sensory memory for visual, it is called the iconic memory or the icons for auditory. So, iconic memory is visual in nature then you have the acoustic memory and similarly. So, different different types of sensory memory are there which actually stores all kind of information. Now keen to what the short term memory does? Short term memory can actually taking a lot of information or a lot of type of information process, a lot type of information. The sensory store cannot do that, it has very clear cut say systems. So, visual information will be stored as icon and auditory information has another kind of storage which is called the echo.

So, not the acoustic here, visual information sorry auditory information is stored as something called the echo and you have such information, sensory information pressure information and so and so forth. So, sensory memory characteristics of sensory memory is first it can store a lot of information, a number of information. The second thing is that requires a attentional filter and this attentional filter decides what information should

pass. Third information stores here is so for very limited period of time, fourth; the information here is almost raw nothing is mentioned here, the raw information is there. Fifth; there are different types of sensory informations; for example, visual informations are information is stored as the icon or there is something iconic store.

Auditory information is stored as something called the echo. So, it is called the echo echoic store and so on and so forth. So, that is the meaning of the sensory memory and that is the characteristic of it not. Now, short term store; now if information passes from the sensory store or it is filtered from sensory store it reaches something called the short term memory. Now what are the characteristic of short term memory? Short term memory can hold 7 plus or minus 2 chunks of item. Now what is chunks?

So, at the maximum it can include nine chunks of item at the minimum it can include 5 chunks of item. What is chunks items? If a number of items if a number of objects are classified under one category it is called the chunks. Let us say that I give you a list of animals; dog, cat, rat, and some bear and so and so forth and if this list of items, there are so many animals. Now if I ask you what this list comprises of you will say these are animals. It can be the list can also be further divided into domesticated versus wild animals but in total it is called a animal.

So, taking this list and giving it a name or categorising this list animals in under one name is what is called chunking. So, all these animals when they are or all these items in the list which is cat, rat, hen, dog, mice and into animals is what is called chunking. So, basically then items which are similar in nature when they are categorises under or when they are put under organised under one category this is what is called chunking and so, the short term memory can hold 7 plus or minus 2 chunks of item. That time how long can short term memory store information?

So, it is less than 30 seconds without repetition without repetition. Now generally what think of short time memory in this way? What is short term memory? Short term memory holds relatively small amount of information for brief periods of time usually 30 seconds or less. Now, assume that you are being given a telephone number. Now when you have a telephone number and you are on a call and somebody gives your telephone number to call to, what will happen?

You will actually have this telephone number and you will mentally repeat it and this is called basically called reputation or rehearsal and if you keep on repeating this number; so, you are talking to this person somebody on the phone and he gives your number to dial to and until and unless you keep the phone or if you do not have a diary to write this number, what you will do is you will mentally repeat this one number and this is called rehearsal.

So, if you keep on rehearsing, if rehearsal is performed then information can be stored in short term memory for longer duration of time. If it is not rehearsed then within 30 seconds of time with some if you are talking to someone and information is a short term memory within 30 seconds the information will be lost until and unless you rehearse it which means that mentally repeat it. So, basically then the storage of information is for 30 seconds. Third the code in which information is stored in short time memory is phonological in nature.

So, mostly the information storage in short term memory is in terms of acoustic code. Generally you hear words you hear acoustic, you hear auditory code or the information is stored in terms of words, in terms of acoustics that is how the information is stored in short term memory. And also what is the forgetting in short term memory, how it is forgot information is forgotten? The information is forgotten from short term memory through something called interference and also something called delay.

Now interference is when similar items are brought together. So, if I give you a list of word if I give you 2 3 words to remember and then I don't let you rehearse it and later on when you when you play back this words it is more feasible or it is more likely that you will actually confuse D with T B with c some kind of a thing like that and that is what is called the interference. So, materials that you have learnt before or materials, that you are learning afterwards that will interfere with each other and that is the code that and that is how forgetting actually happens in short term memory.

Similarly, delay. If information is not used in long term in short term memory for longer periods of time or information is kept in short time memory it is not accessed for 30 seconds you will have forgetting. How will a forgetting happen in sensory memory? Generally forgetting is through a normal process. So, if not used it is mainly decay, if information is not filtered then information is forgotten from long term memory. Now

there is something called long term memory. So, if information is rehearsed, if information is repeated in short term memory it is passed on to something called as the long term memory.

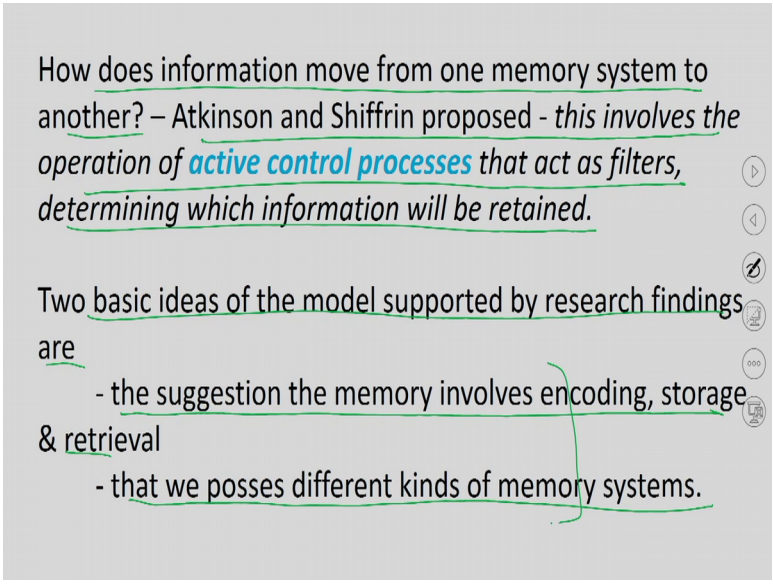
And what is long term memory? It allows us to retain vast amounts of information for very long period of time. So, first thing how much information is stored? A huge, infinite information. So, infinite information is stored in long term memory second how much time it can store from unlimited time right. So, information in long term memory can be stored for unlimited time. What is the nature of information or what is the code in which it is stored? It is mainly stored in semantic form. So, meaning, generally information that is stored in long term memory is in terms of meaning

So, you do not have words in acoustic form, you do not have words and pictures stored in long term memory, what is stored in long term memory is relations between objects. So, certain objects are there and what is the prepositional relation between them that is what is stored in long term memory and similarly forgetting happens through decay and interference. And also something called retroactive inhibition; retrievably induced for getting or when forgetting when you are trying to retrieve information from long term memories another form of forgetting that can happen, generally it is called the theory of disuse

So, if you do not use an information in long term memory it is mainly forgotten. So, that is how forgetting happens in long term memory. Now, what I will suggest is that if you want to have more details about the Atkinson and Shiffrin model or any of these there is a parallel lecture which will be running this semester with the present course which is on cognitive psychology and there what I have done is, I have done I will explain memory in detail. So, my suggestion for you will be to also pouch for or look at lectures on my course on cognitive psychology, especially on memory and that will give you more information.

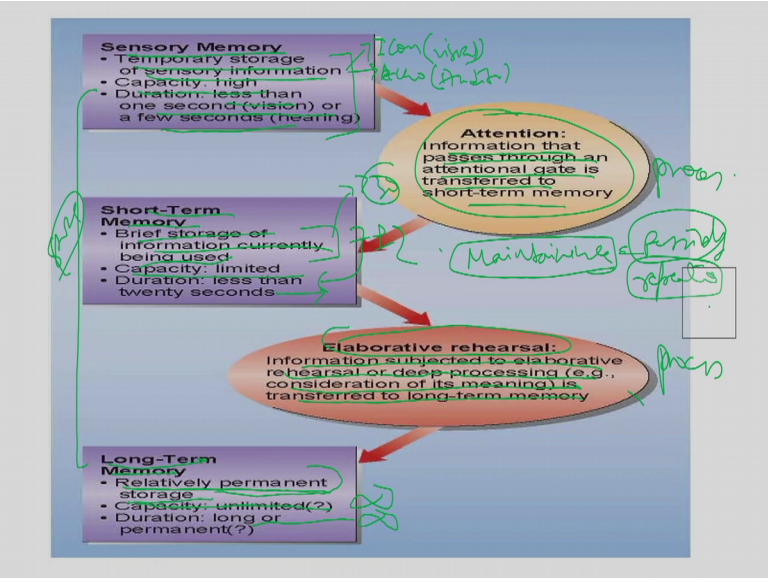
Now, since this is the introductory course we are just touching base with what is memory.

(Refer Slide Time: 45:53)



So, how does information move from one memory systems to another in Atkinson and Shiffrin model? Atkinson and Shiffrin proposed this would involve the operation of active control processes that act as filters determining which information will be retained. Also there are 2 basic ideas of model supported by research findings that are the suggestion that memory involves encoding storage and retrieval and that we process different kind of memory system. So, we will look into this to in a minute or in the later lectures.

(Refer Slide Time: 46:23)



So, basically this is what Atkinson and Shiffrin basically says or the proposal of Atkinson and Shiffrin. Sensory memory, the characteristic is it is a temporary storage of sensory information right and this sensory information as I said could be in terms of icons. Icon is basically visual in nature and the other sensory information could be in terms of auditory information which is called the echo. So, echo is the code for auditory information and similarly there are other codes. The capacity is very high.

As I said a lot of information can be stored here. Duration less than 1 second vision and few seconds for hearing, now when attention is the process which moves information from this store to the next store. So, attention is information that passes through an attentional gate is transferred from so to short term; so, sensory store to short time memory the process. So, this is called the process. These are processes which move information from one store to another and these are called the store which is the where the information is stored.

Now, short term memory brief storage of information currently being used. So, that is what it is 7 plus or minus 2 chunks, capacity is limited. So, 7 plus or minus 2 chunks it is brief duration. So, less than 30 seconds and duration for which information is held is 20 to 30 seconds. Now how is information move from short term memory to long term? Through rehearsal.

Basically how do you rehearse an information? Now any information in short term memory can have 2 kinds of repetitions. One repetition is purely repeating. So, if I give you a phone number you can keep on repeating the digits of the phone number and that is how one way of repeating information in short term memory. The other way is you can assign this phone number to something of meaning. Let us say I give you a phone number which is 9465432864, what you will immediately do is 94 is BSNL. So, that is how from your past experience you will relate that.

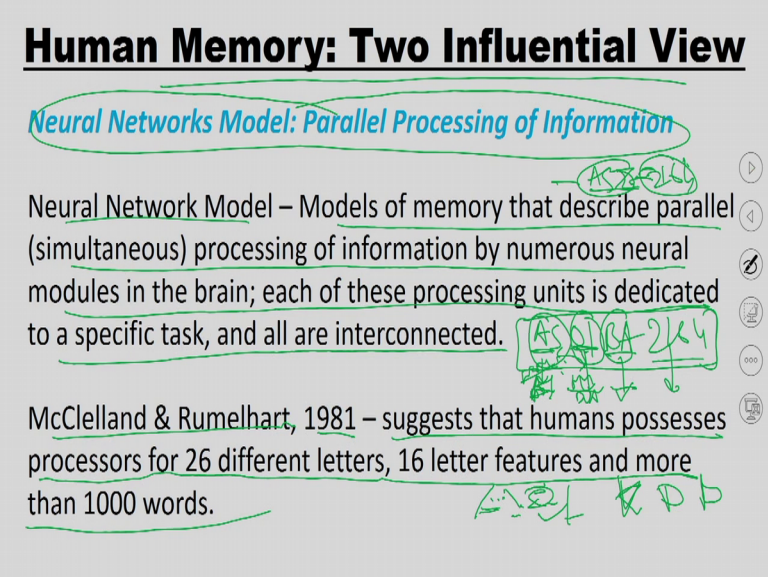
So, 94 is BSNL, 63 is a code for some state and then the other let us say 23 is a area code. So, let us say 94 is BSNL, 63 is assume that it is Maharashtra and then 36 is a particular city in Maharashtra, let us say Mumbai. So, this 3 digits, there is first 6 digits are now available to you. So, you know that this is a BSNL number coming from Maharashtra Mumbai and the last 4 digit is your phone number and that is what is called is call elaborate rehearsal. When you take in information from short term memory and

assign it meaning or give it meaning and that is called elaborate rehearsal. So, information subjected to elaborate rehearsal or deep processing; example consideration of its meaning is translating to long term memory.

So, information is processed, so, there are 2 types of rehearsal. One is called the maintenance rehearsal. In maintenance rehearsal what you do is you passively repeat information. So, if I give your phone number and you do not want to store it for longer period of time what you will do is just repeat the numbers that is called the maintenance rehearsal. But if you assign the meaning to number just I explained as I explained the little while ago that is called as elaborate rehearsal.

When you do elaborate rehearsal information moves through the process of rehearsal from short term memory into long term memory. And what is it? Relatively permanent storage of information that is there, the capacity is unlimited. So, it is infinite capacity and the duration is also unlimited infinite time.

(Refer Slide Time: 50:03)



So, this how Atkinson and Shiffrin saw memory to be. Now there is another view of memory which is called the neural network model of memory or the parallel processing model of memory which is opposing or opposite to what Atkinson and Shiffrin had explained. Now what is the neural network model of memory? The model of memory that describes parallel simultaneous processing of information by numerous neural models in the brain each of these processing units is dedicated to a specific task and are

all interconnected. Now what Atkinson and Shiffrin says is that there are 3 stores and 2 processes in which information is stored into your memory.

But then we know of systems or we know of the fact that information does not pass from one store to another or there is there is something called parallel processing in the brain which means that you can process a number of information together. It is not sequential which means that when something is given to you one information is given to you it is not stored in a sequential way; information can be processed in multiple ways right.

So, and on one end you can process a point you have you can remember a poem, but on the other end you can also remember who wrote this poem all this kind of information is there which means that the parallel processes which is happening in the memory and that is what the neural network model says. It says that parallel processing of information happens in the human brain by different neural models in the brain.

For example, if you are remembering the face of the person whose writing the or the picture of the person who wrote the poem then it is a different visual system which is being active and if you are also remembering the poem or learning the poem, it is the auditory system which is being which is activated and if the story of this person is been told you also start feeling something about this person. So, it is another area which is the amygdala or the feeling area of the brain which is also being active.

So, at the same time multiple areas or multiple sensory organs or multiple channels of information is active. Now which of these processing units is dedicated to a specific task and are interconnected? Let us look at is the best example is to look at RTO numbers, car numbers

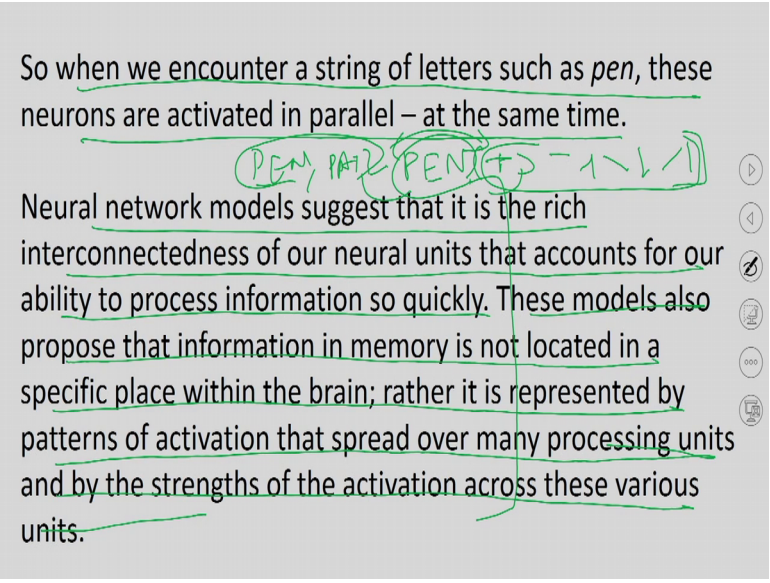
So, if you look at that you have digits numbers digits sorry alphabets digits alphabets digits. Now if you look at that if I want to process the number like this it is easier to process the number like this because what happens is this is the alphabet and so, alphabet is processed by some other form of brain or some other area of the brain, this is digit. So, it is processed by some other area, this is alphabet, so, some other area and some other area. So, this is the visual area and this is the or this is the alphabet area and this is the digit area of the brain. So, mathematical area versus linguistic area.

So, linguistic area and mathematical area they simultaneously work together and when they work together it is easier for you to remember your RTO number or your car number then if it was something like that; ASZ2164 right because here what happen is parallel systems do not work. So, first this has to be processed and first the 3 letters are to be the 3 alphabets have to be processed and then the 3 digits have to be process. In this case alphabet gets process. So, it gets time, the area the region which is processing the alphabet gets time and then the region processing the digit happens and then again the alphabet and the digits.

So, both of them are getting time and both of them are parallely processing as also partial information can also be remembered. Now McClelland and Rumelhart in 1981 suggested that human possesses, processors for 26 different letters 16 letter features and more than 1000 words that is what humans have. They are 16 different letter processing system in the brain, they have 16 letter features to be identified. So, remember letter features which we looked which we looked at in perception. So, you have this angle this angle, this and this and this could mean a K or P because K will have this and P will have this.

And this and similarly we can also have a D which is this and this together right. So, this is the kind of letter featuring system and 1000 words which the human lexicon can have, you all in memory can have.

(Refer Slide Time: 54:23)



So, when we encounter a string of letters such as such as pen these neutrons are activated in parallel at the same time. Now neural network model suggest that it is the rich interconnectedness of a neural units that account for our ability to process information so quickly. These models also propose that information in memory is not located in a specific place within the brain rather it is represented by patterns of activation that spread over many processing units and by the strength of the activation across various units. What does it mean?

It says that information processing signal network model says that it is not one system which is processing information and it is one area which is processing information, there are multiple modules there are multiple systems and there are multiple areas in the human brain which process information's in parallel. So, if I am processing pen how it is happening is one area of the brain is processing the basic features.

So, when I am processing pen for example, one area of the brain is processing things like these kind of letter forms right. The other area of the brain is actually processing words. For example, pen or a 3 letter word starting with P it could be pet, but it has to have this kind of a thing and so, all these words are available, all these letter forms are available.

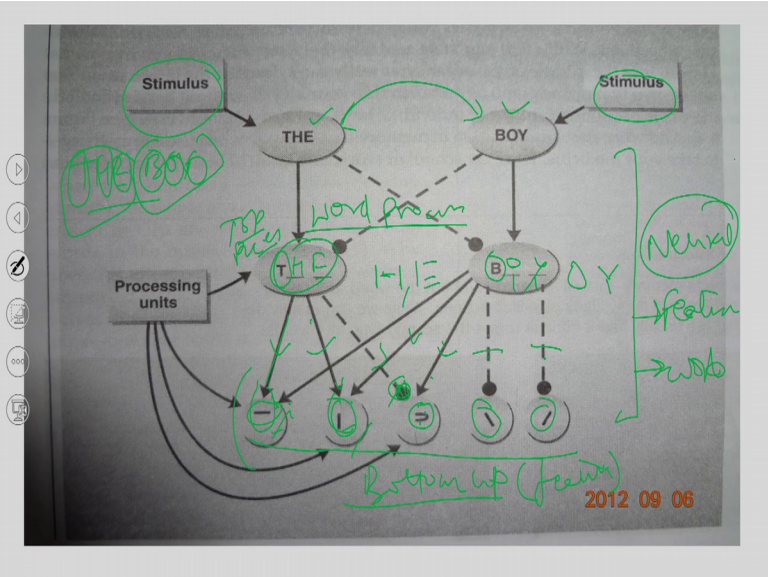
And a third area of the brain is also there which integrates takes this information takes this information and compares this information and this information to the letter pen and then makes a decision that pen is what is being processed. Also it says that the human memory is not located at one place there is no one memory area in the brain rather memory is distributed all across the brain.

For example, there is a region of the brain which is called the amygdala or the basolateral nuclei or there is a region of the brain which is called the limbic system. Now this limbic system is responsible for holding emotional memory. There is a region of the brain which is called the temporoparietal region which holds some kind of special memory or there is the region of the brain which is called the hippocampus which hold another kind of memory which is called the recent memory special memory.

There is a region of the brain which is called the neocortex which holds all kind of memories and then the occipital region or occipital association area which shows visual memory and so, there are different regions of the brain which holds different kinds of

memories and all this information interact together to form the whole memory that you actually see.

(Refer Slide Time: 56:55)



So, then let us look at this. For example, if the stimulus is the boy, now how is THE BOY processed? If you read THE BOY how it is processed? Now what will happen is there are different processing unit. This is called the bottom up processing unit or this used in the bottom up processing unit and this is called the feature processing unit. Now the feature processing unit, what it will do is, it will separate these letters into its basic constituents. What they are made of?

So, I have this kind of a angle, this kind of a line, this kind of a semicircle, this kind of a diagonal, this kind of a diagonal in the boy. So, this processing unit is called the feature processing unit and this is called the bottom up process. Similarly this is called the top down process or I would say a word processor. So, this is my word processor and this is my feature processor. So, feature processor use bottom up processing and word processor use bottom top down pressing.

So, what the word processor will say is a letter or a word which starts with T and has 2 more words into it which should have this or 2 vertical lines and one horizontal line right and in the third letter. So, second letter should have 2 horizontal to vertical line 1 horizontal line and the third letter should have 3 horizontal lines and 1 vertical line and because you are seeing vertical and horizontal lines, so, the only possibility is T H E in

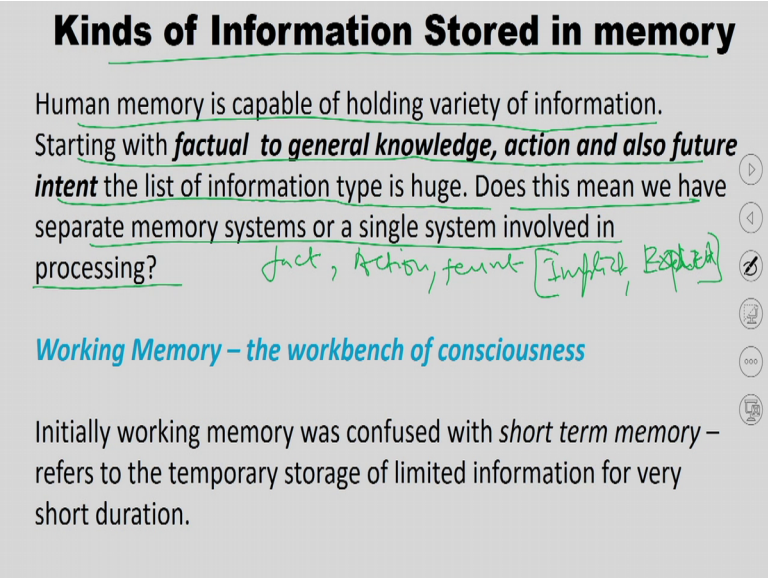
this case; so, a word starting with T ending with H. In this case we do and we have already know that it is the B and so, 2 more letters have to be there; one a full circle the other 2 diagonals and a vertical.

So, 2 diagonal from different shape and so; obviously, it is THE BOY and the connection that you are seeing is. So, T for H this is there, this is there, but this is not there and so, this is this is this connection is not this or this feature is not present and that is why you are seeing this, this particular thing. This feature is present this feature is present and so, you are seeing activating things. Also in this is present this is present. So, you are seeing this as activating and these are as deactivating or inhibitory. So, these are excitatory connections these are inhibitory which means that if this feature this feature if this feature and this feature is present you will have excitatory connection which means that these are approved, but this feature is not present in the and so, it is not approved and so, you will see a dot like that, but these arrows says that the features are present.

Similarly, from the word unit from the from the word side what will happen is not only will this features will be processed, but what will happen is the word since we also have a store the word store is also acting and what it is looking at is how many words can be formed with these features in line and so, we only get THE and that is why THE BOY is how it is processed. So, when we are processing a letter or a sentence this is how the processing happens both at from the word from the word end of it and also from the feature end of it and that is that is how the neural network model works. Neural network model says is that processing happens both and the feature level and at the word level.

But Atkinson and Shiffrin and does not say that it says that processing happens only at the short term memory, in the short term memory and that happens only either using the phonological code or the semantic code depending on what kind of memory that you are using.

(Refer Slide Time: 60:43)



So, this is the primary difference between the Atkinson and Shiffrin and the Atkinson and Shiffrin model and the neural network model. Now what kind of information is stored in memory? Human memory is capable of holding a variety of information starting with factual to general knowledge action and also future intent. So, it is the list of information that is stored in memory. Now, this mean that we have different separate memory systems or a single system involving all kind of memory. Now since human memory can store information which is related to facts and general knowledge. It can also have memory to action and also to future things. So, it has been found out that human memory is both implicit and explicit in nature.

Implicit meaning that there are certain type of memory that you are not aware of. For example, how do you ride a bicycle or how do you play a violin? Now these things you cannot tell or cannot explain. So, these are implicit forms of memory. Similarly, there are other forms of memory which are explicit in nature. You can describe what is happening, you can describe how you are playing a chess or you can describe the name of the president and so on and so forth and these are explicit forms of memories. So, all kind information is stored. And the now the question is whether there are different kinds of human memory or is there one single kind of human memory and multiple processes which is working on to it.

So, what we will do is we will take a break here and we will continue with this lecture in the next class. So, I will do a quick recap of what we did today. We looked at what is human memory and we look at the basic features of human memory of how it actually functions. I gave some kind of a history of how human memory research started and then we looked at what human memories in terms of encoding storage and retrieval. Further to it I also explained 2 basic models of human memory the Atkinson Shiffrin model which shows that human memory is composed of 3 stage and 2 processes and that is how memory is composed of.

And the neural network model which say that human memory is not a singular system rather or a set systems. What happens is human memory has multiple or the modules which process multiple kind of information at the same period of time and that is what human memory is all about. Now in the next class that we do we will look into what is the idea of working memory and how it replaces the idea of short term memory and we will also look at something called long term memory and the kind of information which is stored in long term memory.

Now, again my request to you would be to go back to my other lecture which is on cognitive psychology and maybe spend some time with it view it because on those lectures what is happened is I have gone into detail in explaining these features or these kind of topics which is there, memory and learning and so on and so forth because since this is an introductory course. So, what I am doing is, I am just touching base and explaining to you the very basics of these concepts. I am trying to explain to you how this works in explaining human behaviour, but if you are going to my other lecture on cognitive psychology we have dealt with this topics in detail and these cognitive process in detail. So, until we meet again in the next lecture it is goodbye from here.