Memory
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Lecture - 5
Methods of Studying Memory - III

Hello, I welcome you all today in the lecture series of memory, methods of studying memory. As we studied in previous lecture about the recall, recognition, implicit memory, associative learning and reaction time, today we are going to study a few more measures in this direction. One is source judgment. The source judgment if you see is a very common method which is being used to study the memory. The source judgment is our attribution of where or from whom we have learned something rather than the memory content itself.

So, here the individual is, rather than relying on his consolidated experience or knowledge, he or she ensures from where he or she has learned the information and here the outsource or the available information comes from the other person, as you can see in the cartoon. So, source person ensures that from where the information has been collected and in what form it has been collected and this registration of information the individual is very clear about that he or she is not doing it by himself. So in this instance, many a time people say that when you take a let's take an example, when you are taking class course and a teacher is giving you a lecture on a topic, let's say global warming, and you have taken that lecture. But somehow one lecture, the teacher fell sick. So the substitute teacher, when she or he comes to give to continue the lecture on global warming and gives you the facts and figure the next time you remember what your course instructor has given you lecture on global warming and what a substitute teacher has given you information.

So this is a source judgment where you decide that who has given you what information. In this aspect, reality monitoring is one such parameter, which is a deciding factor, which refers to our ability to distinguish whether our memory is a real or an imagined event. So many a time, the information which we have acquired, the knowledge which we have consolidated, This information sometimes gives us an imagery information or fictional

information. And in that case, our source judgment brings clarity that this information first is a real one or is a fictional one, which is being generated based on your consolidated knowledge or experience or has been collected by some individual.

So, here for instance, then imagined event many a time people see or imagine dating a movie star or being elected as a president of their country. So, this is an imagined event. However, the real event is that we normal being are not being a president and we are just a common human being executing and living a normal day-to-day life. In this aspect, we also understand that the imagination of certain events, certain incidents, which is fictional in nature, how different it is from the real world scenario. So, the source judgment actually brings a lot of clarity in this regard.

Many a time, what happens, that we build misconception, and to remove our misconception we just look for the source of the information. In this source of the information, brings more clarity if the information is coming from a real or a fictional site or imagined site. Second thing, it also gives us information who has provided this information. So in an entire human lifetime, the source judgment is a constant process. It's a very dynamic process. Also, we have acquired some knowledge.

We have consolidated some knowledge. But what we do based on that, as we experience, as we collect information from the other, we try to update and modify this information. The another type of measurement is the metamemory judgment. Metamemory, as we discussed earlier also, is the awareness of our one's own knowledge and memory of memory. So here, metamemory when we are talking about it means our knowledge and awareness of our own memory processes.

How much we recollect? Is the recollection accurate? Is the recollection faded? Is the recollection fictional? Is the recollection real?

Such information is a part of a big domain of metamemory. In this discipline, metamemory judgment is the rating or decisions we make concerning what we know about our memory processes. So, how much we know, how much we are familiar with. And in this metamemory judgment, like previously we discussed about it, that the frequency, familiarity, and dominance play a major role. So based on the context to

context also it varies, metamemory judgment varies. Like a person leaves his native country, resides in another country for work purpose, moving to another country.

So in this way, if a person has been part of three nations, including his native nation, then he or she has to know about the cultural variation. He or she has to know about the cultural context, the decision making, the way people interact, the way the population interacts. And all these decision makings actually can be part of metamemory judgment. So, cultural variation, cultural context play a major role. So, an individual ensures that what I know about the information comes from my native side or the information which I know is because I have been residing in a foreign nation last 10 years, 20 years.

So, the building or the construction or the consolidated knowledge or experience is from this part of the nation. So, this way, you know, person, it is also a very dynamic and constant process which individual do from time to time and make a metamemory judgment. In this metamemory judgment, in memory research, it also refers that whether we think we can learn or retrieve a particular item. So, in this aspect, many a time, like previously we were talking about one aspect, that think of a movie, think of a movie of a specific actor, think of a movie from a specific culture or context. In such aspects, metamemory judgment plays a major role and in this regard also what we know that how much we are we have learned, how much we have registered, and how much information about that particular item we can retrieve.

As we were discussing about the recall memory where the generation of memory is being part of this assessment also. So, the last point says that judgment of learning also are predictions of the likelihood of remembering an item, which means that how much item i remember, prediction of that is going to decide the judgment of learning; that how much i have learned and how much i can remember. So this aspect, the prediction aspect depends also on these three parameter as we discussed earlier about the frequency familiarity and the dominance. So, if frequency is too much, rehearsal is too much, over learning is too much, then the judgment of learning becomes easier and easier. Person can predict it easily and the likelihood of this item is very very common and easy to occur.

The other side of the coin here is these measures, other than these measures, what else we study is the neuropsychology. Neuropsychology study we have been doing and it's not a novel method. In the period of 1930s and 40s, it came like a boom where people were studying the patients with brain damage and they were trying to understand. As you can see on your screen, there are two highlighted brain regions, hippocampus and Broca's area is there. Hippocampus is the site of memory.

Broca's area is the site for speech production. Now the neuropsychological test in the neuropsychological research has tried to correlate these specific brain regions with the cognitive and behavioral deficits. So they just do the correlation of it that certain brain
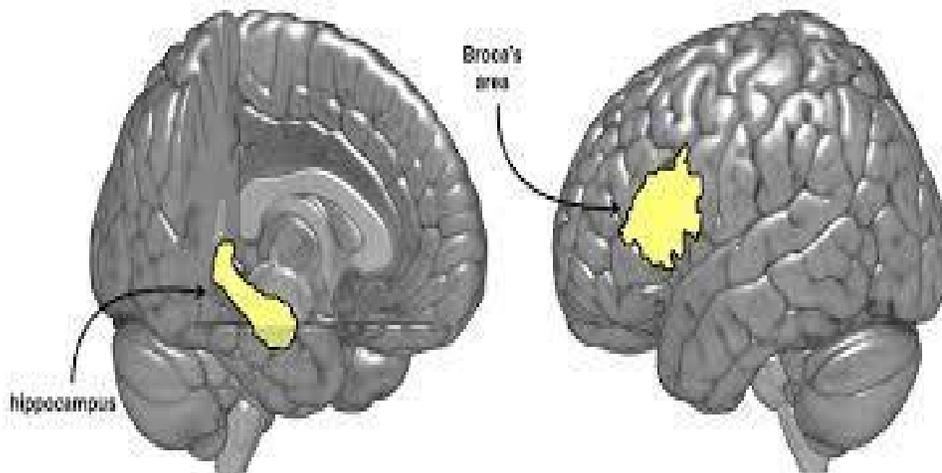
damage or certain functional deficiency might be correlated with brain areas And I think Neuropsychology has done lot of contribution in the discipline in building an insight about the process of memory and till 1950, the period where the research has not been so focused, and where people were just talking about it, that the information is scattered in the brain, information is not specific to the brain structures. This misconception and myth just got broken down with the discipline of neuropsychology.

And I think if you go back to the literature and you will see the 1950, the concept was that the consolidated information is not at a specific site of the brain. And in our lecture, we will discuss about it with the specificity that the brain regions which last few decades people have put emphasis upon the site of memory and as the memory becomes old, then

how it becomes independent of these brain structures. Initially people thought, that the consolidation is scattered all over the brain, this misconception just got away when people in 1950 and 53, they started to bring these researchers, when they started to do neuropsychology research and also the lobotomy, where the brain, certain brain regions are being removed as a part of the neurosurgery. So, damage to the hippocampus can cause amnesia where people are unable to remember the information. And amnesia are of two types.

This part we will be covering in the coming lectures. So, it is of two types, anterograde amnesia and retrograde amnesia. Depends on the incident and the traumatic brain injury when it has occurred and how. And after or before the loss of information, what is happening based on that, the anterograde amnesia is there or retrograde amnesia is there. Damage to the Broca's area can cause inability to produce speech.
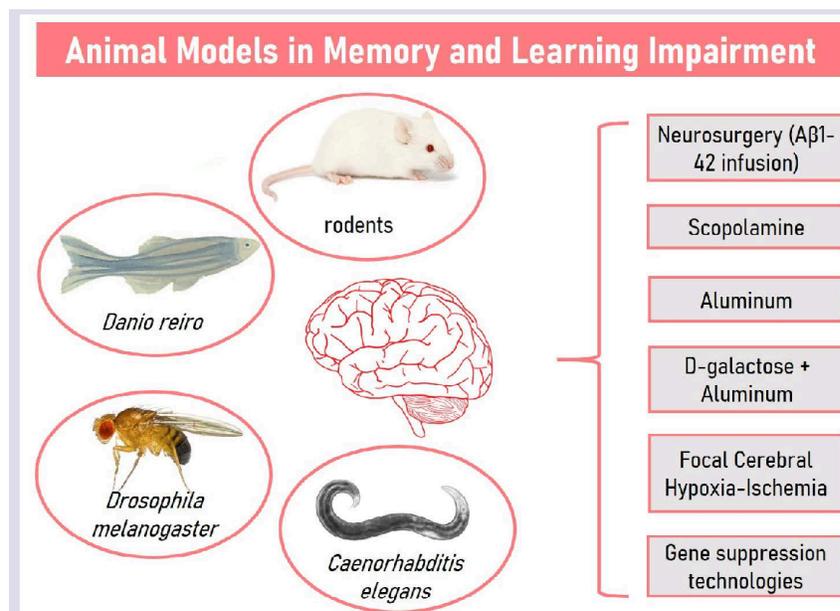
So here, when the Broca's area got affected, then people might have difficulty in producing the speech. Based on frontal lobe damage, memory model can be designed. And I think in last few decades, it has become very popular that people have started to do a lot of frontal lobe damage studies where people are being brought to the lab and then they investigate. Frontal lobe damage actually is very popular in the studies of central executive functioning, where the integration of information is happening from the visual side and the auditory side and other sensory system and frontal brain ensures that the integration of information happens and then the decision making should happen easily. But in the case of frontal lobe damage, we have seen that people, the cost of decision making, the cost of reasoning, problem solving, an individual has to pay if it is not functioning very fine in this regard.

It should be noteworthy here that we discussed only about hippocampus, Broca's and frontal brain damage. Briefly, there are many more brain regions which has been divided by Brodmann and all those details we will be covering in the coming lectures. So, we know from the neuropsychology research, the lobotomy, the brain deficits has given us a lot of insight about the functioning of the brain and particularly with respect to the memory side to it. However, last one century, we have also seen that in-depth understanding has come from the animal literature and animal models. These animal

models are easy to use in the labs and has given us a distinct mechanism related to distinct types of memories, and that is why it has been a very popular approach in the discipline of memory and learning, where different type of animal species individuals have used to study the learning and memory processes.

Researchers have used these models as you can see on your screen, rodents, drosophila, worms are being used and zebrafish which is Danio reiro. So these are few species which I am showing you. And even we have discussed about the Pavlov's dog experiment where salivation was the indicator and how the conditioning and association is happening. In our lectures, we will be also seeing some more species like pigeon, chimpanzees, how they are being used in this learning and memory models. But the most common ones are the rats and the mice, which is being used in the learning.

It is easy to make them learn, and it is easy for the researchers to sacrifice them and study their brain structures. One has to understand that the species which you are seeing on your screen, these animal models are particular only for the learning model. But there are other species also which people have used for other type of cognitive processes such as pigs are being used for social cognition, pigeons are used for visual 360 degree and many more. So, here why we use these animal models because to understand the behavioral, human behavioral side, cognitive side and neural processing side, how it is happening. And these models can be classified as pharmacological method to understand the drug intake, uptake, down regulation, up regulation and how it is impacting the human beings

Animal Models in Memory and Learning Impairment

rodents

Danio reiro

Drosophila melanogaster

Caenorhabditis elegans

Neurosurgery (Aβ1-42 infusion)

Scopolamine

Aluminum

D-galactose + Aluminum

Focal Cerebral Hypoxia-Ischemia

Gene suppression technologies

when they are under medication. Then the another type is the genetic model, where the

certain genes have been knocked out or removed and then we study. And then the toxicological models where certain toxic chemicals or materials are being used to study that if these chemicals or molecules are there in an individual how it impacts their behavioral cognitive and neural processing.

These animal models are generally being like primates rats, mice, etc. as I told you earlier. And these model what they simulate, what they reflect, is the cognitive deficiency such as aging, head trauma is being used. Neuromolecular basis of cognitive functions like zebra fish, i told you, vinegar flies, this drosophila, and the worms which you see is mentioned. So, these models are easy to design in our labs and once it is easy to design in our lab, then we can study these different types of processes such as behavioral, cognitive, affective, social, you know, processes can be investigated. Now, in recent past, you know, these models have given us lot of insight and that is why these are another measures of learning and memory. Now let me take you to the side where the modern tools and technology has come forward and are helping to give us deeper insight about the learning and memory processes and what are these. So one such method is in neuroimaging where it refers a set of techniques that allow researchers to make detailed maps of the human brain.

Now, human brain mapping, why it is important we will see in coming lectures, that this part where the brain resides is the central nervous system. When it sends the signal down the line, then the peripheral nervous system starts to come into a line. And these peripheral nervous systems, the different tools different techniques different methods are there where people have used different methodologies to investigate these parameters. So some common tools which you see on your screen in the cartoon we can talk about, such as the EEG electroencephalography, where we record the electrical signals from the brain. And these electrical signals from the brain the people have used the channels such as 8 channels, 16 channels 32 channels 128 channels are being used. And through these channels these electrodes are being placed on the head using 10-20 EEG system, and from these the electrical signals are being collected. And then the study is being

performed to understand the cognitive processes, behavioral processes, how much time an individual takes to process the information, makes a decision, do the attentional task or memory, and so forth, many other things. Then we talk about the magnetic field or magnetic sensors are being used, that is the MEG magnetoencephalography where the magnetic sensors are being placed on the forehead and then the magnetic sensors are collecting the electrical impulses following the electromagnetic principle.

And then these are also being used to study the the neural processes of behavioral underlying behavioral processes or underlying the cognitive neural processes of cognitive processing. MEG, magnetoencephalography, so both these types are having better time, temporal resolution and spatial resolution is little weak. So, when we talk about the neuroimaging method, it can be classified into two parameters, spatial resolution or temporal resolution. Spatial resolution provides the information based on the brain structures to what depth, to what level brain can be mapped. And a few of these tools and techniques are highly effective than the others, such as we talk about single cell recording, collect these signals from the single cell.

Now a single cell recording, with human as far as I know, the literature suggest that there is no such a study because you have to do the surgery, brain neurosurgery, and then you have to connect the electrode to the one single neuron. Animal model very successfully has been done and has been investigated at several platforms so we get an understanding. Similarly we use the NIRS, near infrared spectroscopy and this principle works on the way simply infrared rays, so the light penetrates to the skull then it comes back based on the refraction parameter it works, and oxygenated and deoxygenated blood. The reflection of light from these two different types of blood, a different wavelength is there, which has been collected from the electrode placed on the forehead. This also comes through the different channels from 8 channels, 4 channels, 32 channels, 16 channels also. Then the another method where the temporal resolution is very bad, at what time, precise time certain mental function has occurred, but the spatial resolution is very beautiful and good. Due to the safety concern the magnetic fMRI cannot go beyond the 7.5 mega Tesla

And this 7.5 mega Tesla fMRI is good enough to give a clear picture which part of the brain is you know showing the um activation than the others and fMRI is also a very uh good tool in this regard non-invasive easily can be done all these tools are non-invasive uh as you can see single cell recording however is an invasive one. Then PET is positron emission tomography. This is also an invasive tool, where an electrolyte or gel or you know chemical is being injected into the individual's body and this gel through blood brain barrier crossing the blood brain barrier through the bloodstream reaches to your brain. And when a certain task mental task has been executed then it interacts and then it reflects upon the imaging and that imaging is being captured through the scanners Using several tools, several methods, modern technology has been provided and there are a lot of transformation happening with these tools.

Researchers working in this domain of tools and methods, they are ensuring the signal to noise ratio should be reduced and how clear a spatial resolution, precise spatial resolution people can have and the temporal resolution they can have it. So, as we see what we have studied in this section, is the source judgment. In the source judgment, what we studied is that the source of information from where an individual is collecting the source of information the source of information is being is real or is it fictional. So definitely the source of enjoyment cannot come from within, but it is coming from outside the world, and who is providing the information. And that is why we discussed about a classroom experiment where the instructor is giving a lecture on global warming and then when the instructor is absent a substitute teacher comes and continue the lecture on global warming shares the some facts and figures then you register this information and then says that the source of information from instructor one and the source of information from instructor two are distinct different and you do that and something which you are acquiring from yourself that is then imaginative or something coming from your within. Then we also discussed about the metamemory judgment, how metamemory judgment is important monitoring how much I am aware of it, and how it helps you to do the distinction between what is real and what is imaginative in nature.

Taking this lecture further, we discussed also about the neuropsychology side to it, where the brain deficits are being used, brain damage cases are being used to investigate and

understand the neural cognitive and behavioral processes. We are going to extend this section in the week 2 also and then the animal models, how the animal models have been efficacious providing an insight and different types of animal model like pharmacogenetic model, genetic model and the toxicological models are there and how their contribution has been a big aid towards the memory research. And then finally, the neuroimaging methods and we discussed a few neuroimaging methods here in this slide. The few methods which I have discussed are the commonly used methods in the discipline of memory and the cognitive science research. That is why this has been shown to you.

But along with this, there are many other methods. So, with this, I end the lecture here and I say thank you for your time and see you in the next week. Thank you.