

Memory
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Lecture - 12
Retrieval of Memory - II

Hello everyone. I welcome you all in the lecture series of memory today. Today, we are going to extend our lecture on retrieval of memory and this lecture number is 12. As in previous lecture, we studied about the retrieval process. We even studied about the feeling of knowing and feeling of knowing judgment and how the feeling of knowing judgment get affected by the frontal cortex.

Let me extend this lecture towards the theory of feeling of knowing. So classical theory on feeling of knowing suggests when we make judgment, we attempt to retrieve memory directly. And the access depends on the strength of memory. The access means accessibility of information. How much access I could have it on the stored information.

As in previous lecture, we have been discussing that the amount of information stored, does it reflect the retrieval process? Or retrieval process, does it indicate the amount of information has been stored or the amount of information one can retrieve? So here, the classical theory on feeling of knowing suggests when we make judgment, we attempt to retrieve the memory directly. Another theory in this direction is the according to cue familiarity hypothesis. Cue familiarity hypothesis indicates people use shortcut or heuristics to get a quick sense of whether the memory will be available or not.

So in this case people look for the cues. The cues which they are familiar with help them, aid them to retrieve the information. But the cue which they are not familiar with, that will not help them. In fact, it will complex the process of retrieval. The third hypothesis talks about the target accessibility hypothesis, which means feeling of knowing depends upon the target itself.

In the brain, when we study the perception, where the meaningful interpretation and categorization is happening, what we do with the categorization? We categorize the incoming stimuli based on fruit category, vegetable category, or many such categories we

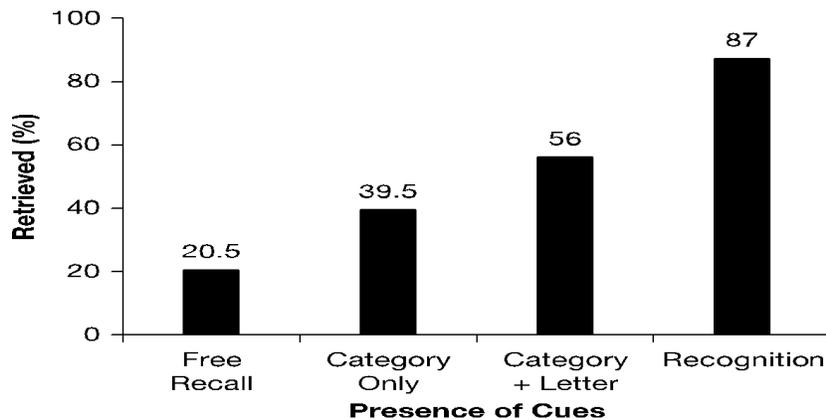
have formed in our memory system for our easiness. and for our remembrance. Too easy to remember. So, when any target is there associated with any of our categories, then the accessibility of that information from that category becomes easy. So, when the fruit is there and fruit is the target, let's say apple is a fruit and it's our target, then we check our fruit category and we do the recognition, we do the template matching. Is it matching or not?

The moment it matches, we access the information. So here, individual attempt to retrieve few details about the memory and then take into account how easy it is to retrieve. So for example, what we do, here is the example you can see. The actor played the role of Akbar in Mughal-e-Azam. Now, If you are, if you have seen the movie, classical movie of Indian cinema, Mughal-e-Azam and if you have seen the different characters and actors, then only you will be able to answer who played the role of Akbar there and who played the role of Jahangir there or who played the role of Anarkali in this movie.

So, this is a specific target or this could be even a cue. Where? Which movie we are talking about Akbar? Because Akbar character might have been played in n number and thousands and thousands of movies. But this is specific cue, this cue becomes specific based on the movie.

So the context has been given to you as Mughal-e-Azam and it becomes specific. And this Mughal-e-Azam can also be seen as a target to us. It doesn't indicate the domain familiarity in many instances. Many instances, people do not, you know, have to be familiar in many cases. In many instances, the feeling of knowing also depends upon the merger of two or more information.

What do we mean with merger of information? Is that when you know that water is a universal solvent, You add salt in it, the water becomes salty, you add sugar in it, it becomes sweet. The emergence of sweet water, the emergence of salty water is knowing the fact that the two informations you have merged them together. Now this is very important part here, where we are going to discuss about the retrieval cues.



Source: Adapted from Hamilton, M., & Rajaram, S. (2003).

The significance of cues, how we are able to retrieve the information. As I gave you an example in the previous lecture is that when you are parking your car in a mall, when you are parking a car near a university, you try to encode and store specific information about the environment. So when you are parking your car in a mall, then you note down the number, pillar number. When you are parking your car near the university, then you note down the department. Then you note down the area, the offices. You try to look around the queues and then you bind these queues with the information and when these cues are being bind, then these cues activate a memory trace.

Memory trace of your stored information. So these cues activate these memory trace. As a result, individual find easiness to retrieve information. So retrieval cue could be prompt or stimuli which aid the memory recall. not only the memory recall but we could even say the recognition. So it aids the memory recognition.

The same thing we could also talk about the retrieval cue can help in remembering. So, we are able to remember the information. So what you see here, there is a free recall. So, retrieved percentage is 20%. When there is only a category only, which means that fruit category, vegetable category, profession category.

And then we talk about the category plus letter. We are binding it. So, the letter indicates the category and the stimuli present in the category. It becomes an indicator. It becomes a cue.

And then we talk about the recognition task where the matching template is required. So what we see is that 87% of the recognition. So retrieval where we discussed about the two different types recall and recognition there is 87% information can be retrieved when the matching is there and the cue, when the letter is being used, then 56%, then 13.5% and 20.5%. Retrieval cues, as we talked about, does not require the sensory system but it can be of two different types. Retrieval can be internal or retrieval can be external in nature.

So external cues helps in the recall and recognition. So if you remember in the previous lecture, we were talking about a person who was being robbed. And when this person goes to the police station and says that I've been robbed. So the policeman makes 10 people stand in a row and ask, please do the recognition. The person from his stored information try to retrieve that information and do the template matching.

And if the match is there, then he says that this is the right one. And this type of cue accessibility or information accessibility based on cue is external cue information accessibility. So the cues are present in the external or outside world. Internal cues can be generated by our own mental strategies. How we are thinking, how we are combining the two thoughts together and then it is generated.

Now one thing we have to understand that there is a concept and notion about emergent features. How does this emergent feature comes? When we try to merge and combine two features together, then it leads towards a novel feature, third feature, which is because of the combination of two events, that is the emergent feature. So, in internal cues also, what happens? Internal cues can be generated by our own mental images.

So, several type of mental images are there. You combine them together and there is an internal cues. Retrieval cues can alter the memory accessibility. How it can alter it? As we discussed, the retrieval cues could be internal and external in nature.

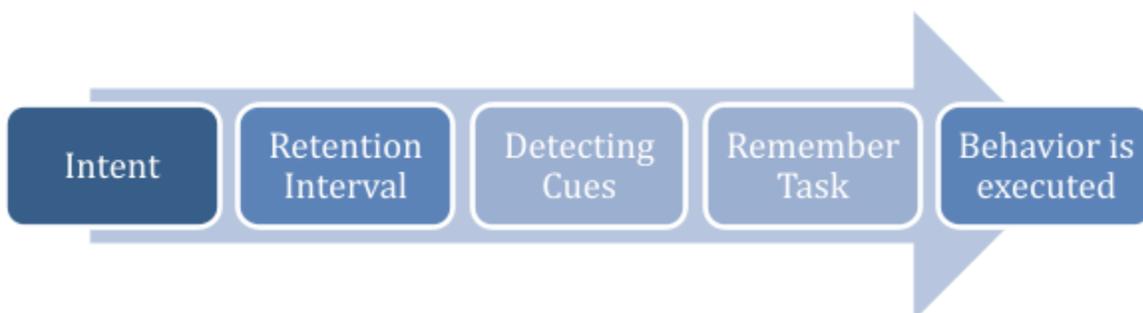
So, at the time of recall or recognition, internal cue, our own mental strategy may influence the recall and recognition. You are going back to your hometown and then doing a navigation. You try to recall the pathway. However, this can get altered by the novel environmental cue present or added into the environment in your absence. So, if the

novel and new cues has been added into the environment in your old environment, then when you go back to that environment, then it becomes little challenging because you may or may not have an understanding or retrieval about those cues. which may alter your memory accessibility.

Talking about this aspect, we have to discuss also about the prospective memory where we talk about the actions required to execute the task. So, retrieving events and memories from the past or retrospective memory. So here what we do, we retrieve the cues and differences between the external and internal cues can readily be seen in the prospective memory. Why? When we are talking about the external cues where the recognition or recall is happening, internal cue when we are trying to emerge out new feature, what we see is that the course of action, the stages of action may vary based on the retrieval cue processes, which is internal and external in nature.

So prospective memory involves both action or the task itself. And it is having five different stages, which we will be discussing shortly. So when we talk about the prospective memory, it may be self-regulated and a matter of self-regulation and self-control is there. Why we are talking about the self-regulation and self-control is because of the presence of the internal cues and its involvement. Some tasks which individual perform, prospective tasks which individual perform, taking out the garbage from the house to the garbage van, paying the dues which is next month or paying the rent. paying the school fees, preparation of the lectures, all these are some prospective tasks.

So when we talk about the prospective memory, the very simple five stage model is there to understand how to remember the future events. So the point here is the intent, your intention, To execute certain behavior. Why certain behavior has to be executed? And how that certain behavior will be executed? The intention is to execute that behavior.



The intention is to give this presentation online. The intention is to take this course for the two credit. So the behavior is going to be executed. So when we are discussing these aspects, the five stages are there. Intention leads towards the retention interval.

And this retention interval ensures the time period, how much time period is required to do a recognition, how much time is required to do a recall, the information which one has encoded and stored. From this time to the time of retrieval, what is the interval? And once that thing is being done, investigated, then detecting the cues, the cues which are available in the environment, external or internal. And once the cues have been detected, because we are bombarded with thousands and thousands of stimuli, and those thousands and thousands of stimuli, out of those, hundreds of cues are there, which an individual can detect, related to the task, related to the behavior, which one has to perform. So out of these cues, we have to now, we have to do a correlation with the task.

What was the task? What was the nature of the task? If the task was to take the bath, if the task was to do your grocery, if the task was to ride a bicycle, based on that, then the cues will be identified, detected, and then after that, the behavior will be executed. Now, some individuals, some of you may feel that this five-stage process is oversimplification of the prospective memory. The answer to this question is yes.

Based on the type of nature of memory, based on the type of the task, the goal, action and the execution of behavior and the sub-stages may vary subject to change. But it has to be clear for us to understand that the model explains the five stages here. Now, let us spend some time about the retrieval. Why retrieval is so important for us? So, initial consolidation hypothesis talked about it that once the information is being consolidated, it cannot be modified again. It cannot undergo malleable nature.

But what we understand, retrieving information makes less vulnerable to disruption as they age. So, this concept and idea is whatever you have stored, whatever you have consolidated, it is less vulnerable. And as the time passes by, it becomes robust and robust. So though you will retrieve, but it will not change that much. It is not susceptible to change.

And that is why I think consolidation hypothesis, when it was given, it was believed that consolidated memory, what does it do? It becomes inert and inactive and get consolidated. Nobody can change it. It goes into a dormant state for the long term memory processes till the information is going to be retrieved. It was in 1960s and 70s when researchers realized that this consolidation process can be interfered and once it is interfered, the information is stored will be interfered so that when the time of retrieval will come, the information of retrieval will be interfered as well or the quantity or the information, measure of the information will be impaired because consolidation has been interfered.

Researchers also talked about because as they mentioned, it becomes less vulnerable to disruption as they age. So time helps in the consolidation process. As the time passes by, the vulnerability decreases. So there is no modification or update can be made. The act of retrieving information makes the consolidated memory vulnerable to change or we can say, makes it malleable in nature, makes it active again.

So once the information is being retrieved, the consolidated memory is becoming malleable. Now you can change it. Understanding this idea, understanding this notion, researchers started to target this vulnerable state of memory by several interventions. One such effective methodology is the pharmacological methodology. The problem with this pharmacological method is that there is a side effect.

Similarly, the other type of interventions are electroconvulsive shock therapy, electrical stimulation magnetic stimulation So once the memory is in active state, once the memory is in malleable in state, you can do you can alter it you can modify it and this modification and alteration is happening because memory is not only time dependent but protein synthesis dependent so when you are using different type of intervention such as pharmacological method Transcranial magnetic stimulation, electroconvulsive shock therapy, these process are interfering with the protein synthesis. And once the protein synthesis is being interfered, the consolidation or the process of consolidation or cellular consolidation will be affected. So, once the retrieval of memory is there and nothing is done, then it undergoes consolidation again. Let us take an example.

You open a Word document file on your computer. Everyone is using computers. We open our Word document file. Or let's say if you are not having any Word document file, you just open a notebook. And on lecture number one, you just wrote it, I am. 12th of January 2024 and you save this file with XY name.

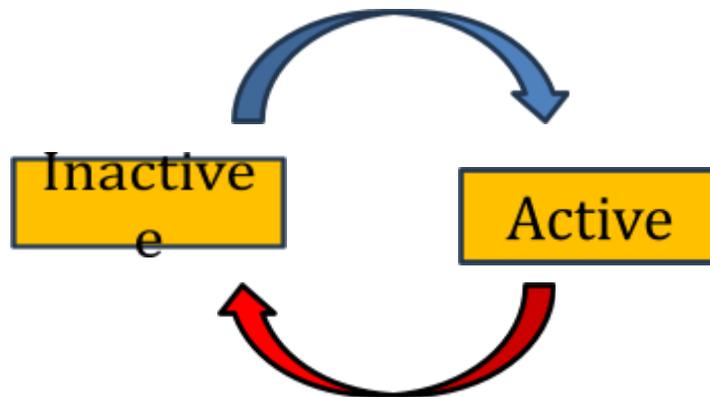
On the date 12th April, after 3 months, when you are opening this document, you update this document with some new information. I am in Delhi. When I am in Delhi, you save this and once you do the saving, see this old document XY is saved again with the XY name after 3 months with some modification. Some modification has been made. Update has happened.

Update where? In this old information. So this consolidated memory upon retrieval, this is this process of retrieval, upon retrieval get consolidated again but this time with some new information. Some circumstances with some memory we do not do the modification, we do not do the update. In that case the memory gets saved, gets consolidated with the same expression.

There is no modification or update. So, when we are talking about the consolidation hypothesis, initial form memory get consolidated, there is no update, there is no change. In 50s, 60s, we realize no. Upon retrieval, upon retrieval, this consolidated memory is upon retrieval, this consolidated memory, this inactive state of memory is becoming active again and this active state, it is malleable in nature, soft in nature. If you do the interference here, then it will be after the intervention or interference then it and you do not do anything, then it gets consolidated again and from active state, it moves to inactive state.

The cycle of active to inactive, active to inactive happens and depends upon the retrieval and the addition of information. If you are not adding anything, if addition is minus, then same impression is restored. If the addition is plus, the new impression will be stored. But eventually, memory is entering into the inactive state. So the classical study done by Misanin, Miller and Lewis in 1968, they reported shock delivered while the memory is being retrieved.

Malleable



Here, right here, the shock has been given to the rats when they were trying to retrieve the memory. This impaired their long-term memory. Why it impaired their long-term memory? Because they were retrieving the old information. The information which they have encoded and stored.

Retrieval is the last stage of memory processing. So if we are interfering the retrieval process, then it is going to impair our long-term memory. If we do not do the interference, then information gets stored with the same expression. Interference of memory after retrieval may even erase the consolidated memory. So, what does this mean?

So, here when the memory has become, when the memory was in active state or consolidated state, upon retrieval when it has become active, you do the interference and the interference with the drug or electrical or magnetic stimulation. Then it is going to even erase the consolidated memory which means the new consolidated memory can be of different expression altogether. This expression and this expression may not be equal will be very different. After decade Lewis did his experiment and suggested time and consolidation is not that very important but state of memory activity is crucial in nature. What does it mean?

This is the consolidated memory which is in an inactive form. Today the memory has been consolidated. Time has nothing to do with the consolidated memory. But once the memory is becoming active, then everything becomes very important and crucial for us. So he, Louis, tried to highlight that in the inactive state, memory has no role, no significance.

But once the memory is in active state again, when it is becoming malleable, then it becomes very, very important for us. And this brought and gave us the active trace theory. When memory is being informed or being retrieved, it is active and becomes malleable in nature, as I told you earlier. This is what active trace theory talks about. When there is an active trace is there, when the memory is labile in nature, when memory is malleable in nature, then it is sensitive.

Sensitive to change, sensitive to modification, sensitive to updating with new information. And this brought me towards the reconsolidation theory. What is this reconsolidation theory talks about? That from inactive state, once the memory is being retrieved, it becomes malleable in nature. As a result, it becomes active state, malleable state, labile state. So retrieval is making memory malleable.

Retrieval is making memory labile, sensitive to change. Sensitive to change and this active state if you do not do anything then the consolidation will happen again and this consolidation which is happening again, we call it as reconsolidation. Reconsolidation may modify or remain intact, the information it may modify the information if you add any information here when the memory is in active state then the reconsolidation will save information with some new information, or it will keep the information intact so memory reactivation makes consolidated memory malleable in nature, so this retrieval is memory reactivation. Though they are different processes, but they share similarity. So once the memory is being retrieved, it is making memory reactivated.

And this reactivated memory is time dependent and protein synthesis dependent. So, if you don't do anything, reconsolidation window will stop in 10 minutes. Roughly, as per the literature. If you do anything in these 10 minutes, then the process will be interfered, and the expression of the memory will be different. This 10 minute window can go up to 6 hours.

This is subject to rehearsal or over learning. Nader reported that retrieving a memory causes a kind of amnesia at the cellular level. So he suggested once you have reactivated a memory, once you have retrieved the consolidated memory, it is causing a kind of amnesia, memory loss at cellular level. Why amnesia he was reporting is because once

the memory has moved to active state from inactive state, then there is a window where you can update the information. And in the case of update, the old impression of the memory will be registered differently with some new information, novel information.

Retrieval opens a way for the updating of old information. How can we update the information? Retrieval gives us that opportunity. The question we should be asking to ourselves, why do we need to update our memory? The reason we have to update our memory is for its longevity.

If we update the old information with some modification or we do retrieval, retrieval not only updating the old information, but retrieval is also maintaining the old information. Once this maintenance is there, once this update is there, the longevity of information in long-term memory increases. And that is why the individuals who keep on retrieving the old information, old memory information, they tend to do the rehearsal, as I said, subject to rehearsal. As a result, this information upon rehearsal and upon retrieval helps in the maintenance and update of information. So, reconsolidation theory is also known as trace updating.

What is this trace? This is the memory trace. This trace, we are talking about the memory trace. What is this memory trace? This memory trace is nothing but it is a consolidated information. which an individual has done long back and that is why this trace is getting updated or this is why the consolidated memory is getting maintained.

So, reconsolidation theory suggests two things. First, maintenance of old information and second, updating old information with some new information. So what does this mean? This means that imagine that we know that snakes are poisonous. But as we grow up, we come to know that not all snakes are poisonous in nature.

Water snakes are not poisonous in nature. So if they will bite you, you may not die. There is a scope of survival. But if the desert snakes will bite, then you may die. So this is what you do.

You update the information and also you are maintaining the information. So let us stop here. And let us see what we have studied in this course. Today's lecture is that the inactive state of memory is there. Active state of memory is there.

Retrieval is making our inactive memory into malleable, labile, sensitive to update or modification. Once this active state is there, you do the update, reconsolidation will happen and the information get consolidated. So this is state of reconsolidation. Once the memory is becoming active and storing it, it becomes consolidated again. It can be from 10 minutes to 6 hours subject to rehearsal.

We talked about feeling of knowing. What do we know? How retrieval is playing a crucial role? Recall, recognition, retrieval cue. Could be of two types, internal cues, external cues.

Then we talked about the prospective memory. From intention to the execution of behavior. Five stages. Based on the task, these five stages may also vary. Retrieval of consolidated memory gave us head to revise the consolidation hypothesis. Revise the consolidation hypothesis where we believe that once the information is consolidated, it becomes inactive.

There is no subject to change. There is no subject to modification. Very soon we realized that upon retrieval, the consolidated memory can be interfered. And once the interference is happening, amnesia could also happen. And when amnesia is happening, you are updating and modifying the memory. So long-term memory can be impaired upon retrieval, upon reactivation.

This gave us the new idea of consolidation hypothesis, reconsolidation hypothesis, which talks about that when upon retrieval, the inactive memory becomes active, Once it is becoming active, it is malleable, labile in nature. At this time point, if you update the information from 10 minute window to 6 hours, then the expression of the consolidated memory will be different from the previous memory. This reconsolidation hypothesis could be used as a therapeutic procedure towards the anxiety and related disorder and it could offer a method of of drug-free paradigm. Reconsolidation hypothesis is effectively

and efficiently being used in drug therapies also. Now, with this, I will end my lecture here and in next lecture series, we will continue talking about the retrieval processes.

Thank you all. Have a nice day.