Memory

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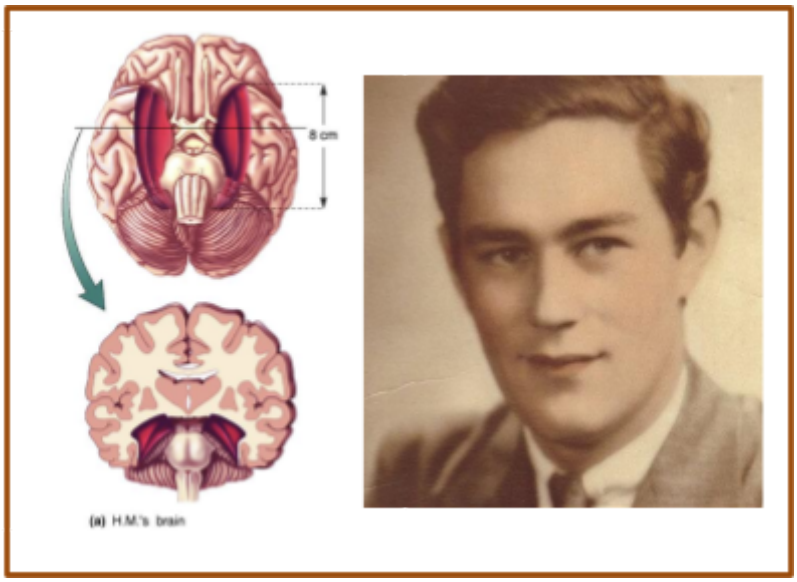
Lecture - 10
Methods in Memory Modulation

Hello, I welcome you all in the lecture series of memory. Today, the lecture we are going to talk about is the methods in memory modulation. As in previous lecture, we discussed about the case study of Henry Mollison in detail. We have to understand, the first classical case came in 1868, Phineas Gage case study. Phineas Gage, railroad worker, he was doing the mining to explode and working with the explosive,

One day, he was planting the explosive, the metal rod on the rock and when he exploded the rock, the metal rod came out and went through his chin and came out from his frontal cortex. Phineas Gage survived this incident and after his recovery, certain changes has been observed. There were behavioral changes and there were cognitive changes. His personality changed altogether. But till that date, people were not very much familiar the role and the functionalities of the brain, the localization of brain functions, the localization of memory processes, attentional processes, visual processes.



Source: https://commons.trincoll.edu/hartfordbrain/2022/02/25/henry-molaison-tour/

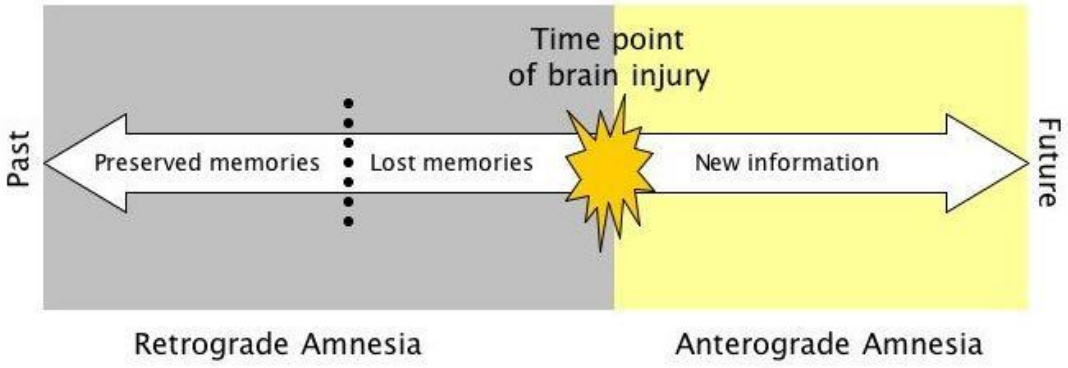
As the time passed by, In the year 1950, till that period people realized that memory is getting consolidated or stored in the entire brain regions. When the smart young 27-year-old Henry Mollison came and came with the problem of epileptic seizures and burnout, the doctor suggested a simple treatment, the lobotomy, where they just had to remove the roughly 8-70 meter brain region of medial temporal lobe. The medial temporal lobe was successfully being removed in the Henry Mollison case and after the removal, the individual started to face the memory problem. He was facing the specific memory loss problem where he was not being able to form the new memory. He was not being able to form new memory but his old memory was remained intact.

Learning the Henry Mollison case in detail, researchers came with an understanding that human cognition is localized. Human cognition requires the brain functionalities. Human cognition initially requires the brain structures for the processing. As the information gets consolidated, as the person gets more experienced, these become independent of structure. That very moment, then the Phineas Gage case study was also being brought up and then the relationship between the two case studies extensively being studied.

Now, the Phineas Gage, the injury happened in the frontal cortex. As a result, the decision making, personality, reasoning changed altogether. In the case of Henry Mollison, the neurosurgery was being performed and the site which was being removed was associated with the memory processes. These two case studies gave a lot of insight to the memory researchers to understand how the memory loss is happening. Now, the two types of amnesia which people have documented and talked about, one is the retrograde amnesia, another is the anterograde amnesia.

Source: https://www.simplypsychology.org/phineas-gage.html

The word which says it starts with a which means after the surgery we call it as anterograde amnesia and something which is backside reverse or before the surgery, we call it as retrograde amnesia. Retrograde amnesia talks about that the new formation of new information is intact you can one can easily form new information however the previous information is impaired person before the surgery do not remember any such information. Now, in anterograde amnesia, the past memory, the previous memory remains intact while the new formation of memory get impaired. And easily understand this thing, there are several Bollywood movies, cinemas you might have seen where the individual loses his or her memory after a head is struck with a stick or after certain incident. Jokes apart, one thing is very clear here is that the incident is doing something to the brain and it is transforming and changing the brain into certain way that there is a memory loss being seen. Impaired capacity for the new learning result in loss of



Source: https://fnfdoc.com/amnesia-types-symptoms-causes/

memories acquired prior to the injury leads to retrograde amnesia.

Timing is an important concern here. Understanding the amnesia, definitely researchers want to improve the memory. An individual who is having and facing a challenge for formation of new memory or the individual who has lost all information about the past memory. The easy, the different methods and tools and techniques has been provided by the doctors to these individuals so that they can maintain their memory and update their memory and retrieve the relevant information from their past. So, the easy task is to maintain a diary the individual who cannot form a memory the diary preparation is an easy task those individuals who are not able to remember the past information prior to the

surgery these individuals are being requested and suggested to go back to their context more frequently to explore, to accustom themselves to the past history more and more frequently so that the recollection, the rewiring or the excitation of the prior stored information can happen. And this way, the individual can enhance their memory and the lost information can be retrieved. So, there are certain chemicals which people have been using it and seem to have a memory enhancement effect. Coffee. Coffee seems to be a very, very simple thing.

Having caffeine in it, consumption of coffee seems to have a positive effect on the memories and has been seen it increases, caffeine increases the alertness. and consciousness in the individual. As a result, the individual may register or encode information in a better way than in normal circumstances. Over-the-counter and prescription drugs, many a time, we have seen that people consume chemicals or drugs. As a result, the side effect of these may affect the memory. Too much caffeine consumption can have reverse effect, which means that it can impair your consolidation process.

It can affect your consolidation process. It can affect your short-term memory retrieval and information as well. Similarly, nicotine and the alcohol consumption can directly impact your consolidation processes. Certain drugs seem to improve our alertness and consciousness and how long we can stay awake and focused, give us more time to learn. It should be very clear here that as we have been discussing earlier, there are more than 100 types of neurotransmitters are there out of which 30 neurotransmitters seems to have a direct role in the psychological functioning and among these 9 have a major role.

And we discussed yesterday 6 types of neurotransmitters playing a major role in the learning and memory. So, no drug till date has shown any improvement with the memory efficiency in the healthy adults. However, minor change or minor modification has been addressed and has been reported. It is noteworthy here that the pharmacological method seems to be the better drug treatment intervention procedure towards the pathological learning and memory. However, the side effect is still unknown and that is why last two decades researchers, memory researchers are trying to find a novel methodology where a drug-free paradigm could be used to treat the pathological learning and memory.

But as pharmacological method seems to be positively correlated and effective towards the pathological learning and memory, so the drugs seem to be the sole intervention method and effective method towards the treatment this drug such as the benzodiazepine this is very common drug used in the memory with individuals with anxiety individuals with insomnia and with muscle relaxation It seems for relaxation of the calmness of the body or somebody who is having irritation due to lack of sleep, this drug seems to have a positive effect. However, indirectly, it affects your episodic memory and also leads towards the temporary anterograde amnesia, which means after the consumption of the drug, the new memory formation seems to be a little challenge here. Individual may not register and store information as the time passes by. But the application and the person who gets relieved from the anxiety, insomnia, muscle relaxation, for them getting relieved from these disorders seems to be more than getting compromised with their memory processes in a long run.

As a result, the side effects of these drugs, there is an interest in the research community to come up with a drug-free paradigm and that is why as we discussed earlier, the neuro-stimulation procedures which can contribute and provide a novel tool towards the memory modulation and with the zero side effect benefits. Another effect is the cholinergic on memory. And when we talk about the cholinergic drugs, what we have seen is that these drugs seem to make the memory better and improve. However, this effect is not a long-lasting effect. Its effect seems to be correlated in certain contexts and for some small period of time.

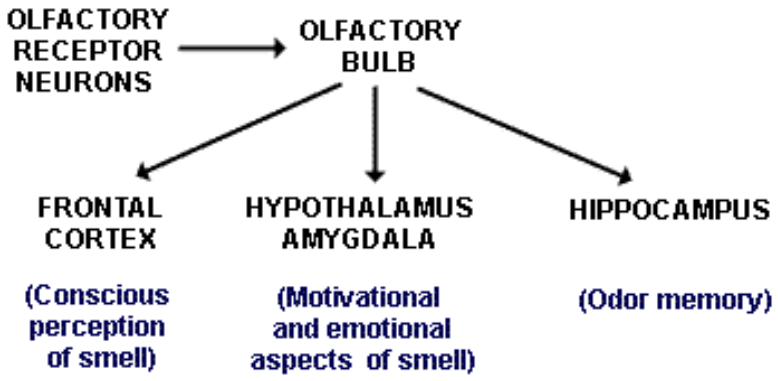
But the effect seems to be very very beneficial for those individuals who are suffering with Alzheimer. Alzheimer is an umbrella term where the memory loss is a big problem. So in these individuals whose day to day activity is being compromised, these individuals who cannot do their daily activity task, for them the small aid from cholinergic drug can, is not only boosting their memory performance, but actually providing an aid to an individual, giving them a hope that with which they can retrieve, recollect, encode new information and use the information at appropriate and specific time. So such aid seems to be have been being provided by the acetylcholine also neurotransmitter as we saw this drug and we discussed this drug in the previous lecture also along with other many

neurotransmitters such as GABA, serotonin etc. Another type of commonly used drug which has been prescribed in the Alzheimer is the Aricept.

Now, all these drugs which we are seeing or we are discussing here, these drugs have been a common clinical procedures. Doctors prescribe these drugs to the individuals suffering from the memory problem, particularly Alzheimer. The listed drugs cannot be generalized to other forms of memory disorder. Because these drugs can have severe side effects. Based on the individual, the drug's prescription is being given.

So, it should be noteworthy here, whatever drug the individuals are using for the betterment or to boost the memory performance, an individual physical and medical condition is very crucial in this regard. So, these individuals cannot just take any prescribed drug. Proper, under medical guidance, these drugs should be taken up. So, early Alzheimer or other form of dementia, elderly are using these drugs to boost their memory performance and execute the memory task. It also allows some temporary improvement of memory performance and speech fluency.

The individuals who are having speech problem, these individuals could also use these drugs, cholinergic drugs and these drugs can provide an aid to these individuals. Moving further down the line, we have to understand that memory is not only being limited in the area towards the neurotransmitter, but some additional brain processes or human physical processes are also aiding the memory. One such process is the olfaction through olfactory system. Olfactory system is a type of sensory system with the smell related to smell and it has seen that the smell has direct role and projection to the frontal cortex, hypothalamus and hippocampus. And that is why something which is pleasant in odor, we try to register effectively. Something which is having a foul odor or bad odor, unpleasant odor, we remember this thing for long period of time. Think about the bad smell of sulphur.

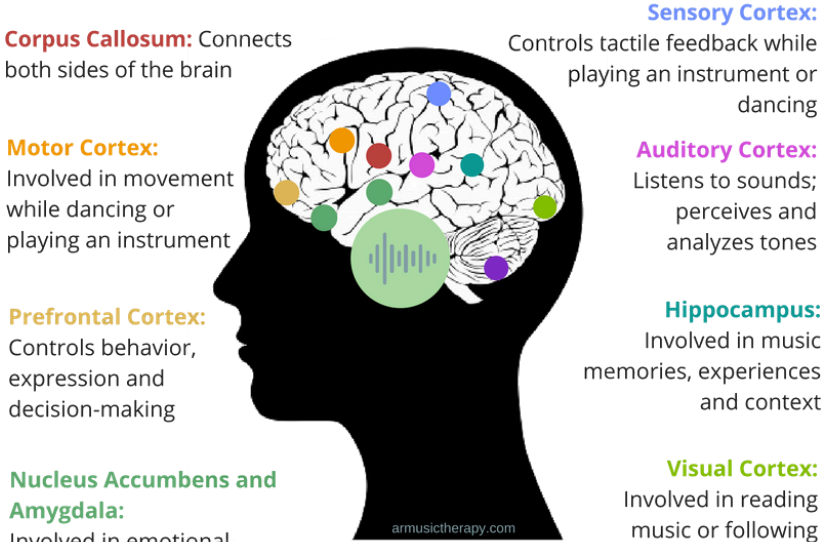


Sulphur, the smell from the rotten egg is such a foul smell that in our childhood we smell this and it remains forever with us.

Source: https://faculty.washington.edu/chudler/chems.html

Similarly, the foul smell from the foot or the foul smell from the dirty water or foul smell from the kitchen garbage. Such odour also provide an aid to the human memory. So these type of memories, if we talk about these odor memories, provide an assistance to the hippocampus. Now because the olfactory bulb and olfactory receptor neurons are quite active and they have dense projection to the frontal cortex, it affects the memory directly. Okay, so odor elicits the retrieval of highly personal autobiographical memory. In some cases, we have seen that the female or the male suffering from the PTSD, the smell can trigger their trauma long back as long as 20 years later also or 30 or 40 years later also.

Such is an important aspect because this suggests that the olfactory bulb, the smell has dense projection to the hippocampus, the primary site of the memory and also the decision from the frontal cortex. The discrimination and distinction made at the different olfactory stimuli is a crucial part where frontal cortex is providing an aid to the hippocampus distinction between the different type of smell and then the registry of this specific olfactory type of olfactory stimuli in the human memory system. Information from olfactory bulb goes directly to the frontal cortex where the decision takes place and the olfactory bulb is now connected to the hippocampus and amygdala. Now, if you all remember in the previous lecture, I told you that three important brain regions are there with respect to memory, hippocampus, primary site of the memory, amygdala, emotional information and frontal cortex, which decide which information need to be stored, which



information need to be forgotten. So the memories elicited by the odor are usually emotional memories.

So these emotional memories are being decided by the amygdala and the frontal cortex, hippocampus. All together these brain regions are coordinating with each other and after the coordination they send the information back to the olfactory bulb where the information gets stored for a long period of time. We have to also understand that music

Source: https://www.armusictherapy.com/music-therapy.html

seems to play a major role in the human cognition. From long time, music seems to affect the different pathway, has adopted different neural processing, which seems to relaxing a mind, relaxing the neurons under stress and also the traumatic brain patient injury. The music therapy seems to be the highly efficient and effective with respect to the control group.

It has also been seen not all types of music can provide the soothing effect so nature healing music seems to have better effect if we talk about the Indian classical music then different types of ragas different types of rags are there from morning period to afternoon period to evening to the night and as per the different time periods are there different rags facilitate and stimulate and produce different types of neurotransmitters in the human brain system. This type of studies definitely require extensive research in this direction, but the available literature at least indicate the ragas, different types of ragas seem to have a positive effect over human memory in an Indian context. Similar studies we can see in the music literature from Beethoven music and from the nature healing music, classical music, etc., and etc., We have also seen the instrumental music seems to have better effect than the non-instrumental music. Music alone doesn't affect the brain or a specific side of the brain is not there but collectively it starts to affect.

So corpus callosum connects both sides of the brain when the music is being presented to them then the networking seems to be so well established that the left brain right brain coordinate with each other in a very smart and fashionably way. As a result, music seems to have a better effect motor cortex involvement in while dancing and playing an instrument so an individual who is playing a music seems to build and establish new neural network and structures which in a long run seems to play a major role, the

coordination of this motor movement with the frontal cortex and the registry of this information, the integration of this information passed down to the amygdala, sorry, hippocampus. And amygdala provides the emotional value to it if the music is pleasant or unpleasant in nature. So the coordination between these three to four areas ensures that the enhancement and robustness should be there in the memory processes. So we also discussed that the prefrontal cortex controls the behavior, expressions and decision making.

Amygdala involved in emotional reactions to the music. Sensory cortex controls the tactile feedback playing an instrument. So playing an instrument, singing a song, listening a song, all these three are different types of processes. However, they may involve the similar neural structures. They may not have identical processing, but they may involve a similar neural structure and some distinct neural structures.

Auditory cortex listens to the sounds, perceives, analyzes the tone, distinguishes the tone, what is the pleasant, what is the unpleasant. Amygdala assessed in this regard that this is an unpleasant sound, this is the pleasant sound, let's pay more attention towards the pleasant sound. Frontal cortex decides this is the pleasant sound, let us spend more time with the pleasant sound and send information to the hippocampus for a long period of time. So, if you listen as concert, music concert in Italy, Rome, then the similar concert you expect to be listened in New York or in Agra Taj Mahal. Then the hippocampus registers these information and experiences the context.

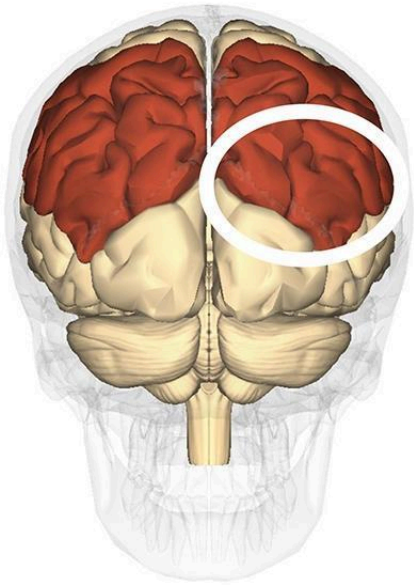
Visual cortex involved in the reading music or following the visual cues. How the note has to be registered? What kind of note is there? And now imagine and see, understand this thing that so many types of brain regions are involved when the music is being played. Now, when the music is being played, the similarity with the memory structures are there already, frontal cortex, hippocampus, amygdala.

Such similarity ensures and coordinates and integrates in such a way that the music always tries to support and aid the memory processes. So the individuals who listen to the pleasant music seem to have better memory processes, better retrieval, better recall, better recognition compared to those who seem to be limited with the music system or music

processing. Music induces the emotional autobiographical memories. We do have some emotional autobiographical memories. With that, music is being processed primarily in the right hemisphere.

Right hemisphere is associated with the emotional brain and that is why music has some biasness, preference towards the right hemisphere over the left hemisphere. The left hemisphere which is the logical brain and involved in the logical processing. So, here we come back to the parietal cortex, the parietal cortex which is related to the perception and attention processes of consciousness. So, right parietal cortex in musical memory. So, right side of the brain, emotional perception or emotional sensation could be seen as and how it is being played role in the musical processes.

So, a TDCS study, neuro-stimulation Transcranial direct current stimulation being provided at the right parietal cortex. So right parietal cortex and left parietal cortex to serve as a control, keeping 5 centimeter distance between the two electrodes. So this side is the control, this side is the active site. When we do such thing, then we pass the electrical current. So, right parietal cortex resulted in person recognizing fear of the



melodies.

Source: https://cviscotland.org/mem_portal.php?article=254

When such a stimulation is being done, what researchers observed is that people are recognizing the fear melodies. Few melodies are being reported. So, this active site and this is the control site. And this process, contralateral process. Now, so the stimulation of the right parietal cortex interface with the memory of the musical melodies, critical area in music perception or musical learning so parietal cortex we know that it's important for the musical learning so if somebody has to learn more music somebody has to do less music learning then these cortical areas could be used and stimulated of course one should be clear that neurostimulation particularly TDCS is not a standardized and established tool is there.

Some countries, it is extensively used, but some countries, due to ethical reason, it is not being used. Now, summary, let me walk you through what we studied in this lecture is the retrograde and anterograde amnesia. What we understood is that after the surgery, after the surgery of Henry Mollison, when the removal of medial temporal lobe happened. Then people were not able to, then HM was not able to form new memory after the surgery that was anterograde amnesia. When your formation of new memory is okay, but your old memory become impaired, that is the anterograde amnesia, which means you cannot recall or retrieve any information before the surgery.

There are certain chemicals which play a role in the membrane enhancement. However, these chemicals not only being affecting the membrane enhancement, but seems to have some side effects. As a result, some drugs such as benzodiazepine, cholinergics, seems to be beneficial in the case of Alzheimer's or dementia or frontopolar dementia etc. But in the case of normal healthy individual if these drugs can be taken then it may have different consequences altogether. We have to also ensure that not all type of memory can be enhanced using these drugs.

Only specific type of memory can be enhanced. So the nature of memory is very very important and the dependency of these drugs should also be investigated. and can be taken under the prescription of the expert. Memory and olfaction. Olfactory system, the smell system seems to have a positive effect over the memory formation, memory consolidation. Pleasant smell seems to have robust effect on the memory.

Unpleasant seems to have more robust effect than the pleasant and the neutral olfactory stimuli. In the olfactory stimuli, olfactory system, olfactory bulb seems to have dense projection to the frontal cortex, amygdala and the hippocampus. The projection, dense projection ensures that the memory formation should be robust and should be long lasting. Then we also studied about the music and memory. We saw that the music involves more than four to five mental functionalities, four to five brain regions and there is a huge overlap between the music and the memory structures such as the frontal cortex, hippocampus, amygdala, the triangulation formation, the coordination, integration among these different brain regions play a major role in the robustness of memory formation.

Music seems to have a better effect on not only on memory, but different types of cognitive processes and music therapy is a very well established field and line of research. If anyone is interested in, then you can check the music cognition and the effect of music on human cognition. For several case studies, few case studies which I have discussed with you today, I have acquired from the internet. However, if you are interested in the case studies to understand the neuropsychology of the underlying mechanism or memory processes, then this book, Fractured Mind, can be a very good book by Ogden. And one can go through this book.

There are several new innovative case studies are there and I think the revised version has also come forward. So such books, you can refer it to have deeper insight about the several case studies in the discipline of neuropsychology. With this, we are finishing the week 2 lecture series. Next time, we will start the week 3 lecture series in the memory and we will start with lecture number 11. Thank you all for your kind attention.

I rest my case here. Thank you.