

Memory
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Lecture - 19
Working Memory - IV

Hello, I welcome you all in the lecture series of memory. Today, the lecture number 19, we are going to talk about further about the details of working memory. In the previous lecture, we discussed about the working memory components, the role of phonological loop, the role of visual specialist sketchpad, episodic buffer, collectively putting an effort to provide an information to central executive system to take an action. Now, working memory, how it is being stored in the brain, different brain regions, how they are supporting and helping the working memory, this is an important concern and the final concern for this lecture. In this case study, KF's case study, we understood that in 1970 when KF met with a motorcycle accident, he was suffering with the brain damage.

The damage happened in his left occipital lobe. But the unique characteristic started to emerge in the KF's case study. Unlike the Henry Mollison case study, which we discussed in the previous class. So, you can just go and check the Henry Mollison case also in the previous class. Along with Henry Mollison case, we even discussed about the SM case.

So, what was the unique nature about these two different case studies? You can just go through it. Here in the KF, it was unlike the Henry Mollison case. In the Henry Mollison case, when he was not able to form new memories, KF, the new learning was not a challenge and the retrieval of old information was also not a problem. However, his working memory capacity, his working memory formation got impaired.

So, in this unique way, researchers tried to investigate how he is able to form new memories but is not being able to execute the task related to working memory. Now, if you see in the previous lecture, we discussed about the different brain regions. So, we discussed about the frontal cortex, we discussed about the Broca's area and the Wernick's area related to the PL, phonological loop and the central executive system and the visual area, the visual area for the VSSP. Now we learnt previously that the projection is

happening from the frontal cortex to the VSSP and also some projection is going from the phonological loop to the VSSP and some projection is going from frontal cortex to the phonological loop. These projections are so dense in nature that sometimes this projection provides an aid to one another.

But in the case study what we realized that when the lesion happened in his visual area, this visual area compromised got compromised as a result the projection from the frontal cortex to the visual area was not there, so any type of information any type of visual processing information got impaired now the unique part to this is the digit span task digit span task where individual not only have to remember the digit, But he has to rehearse those digits and rehearsal of those digits then he has to keep it in his working memory for a period of time till he moves to the second trial, third trial, fourth trial, fifth trial and so on. And not only he has to do the rehearsal and keeping it into his working memory but he has to retrieve that information. This requires an integration of visual working memory along with the auditory working memory. So, what we realized is that his shutter memory got damaged.

As a result, the working memory was incapable to provide an insight of the visual working memory capacity. So, visual working memory capacity and capability just got compromised. As a result, only auditory working memory was there. Now, LTM functioning was normal in this individual. So, he was able to retrieve the information which happened in his past and also new learning.

Why his LTM was functioning normally? Because in previous lecture, we have studied the site of location for the long term memory become independent of brain structures. So, it does not depend on the brain structure which is the hippocampus. In some instances, definitely hippocampus is providing an input to the other brain structures, which we studied in the Henry Mollison case, by the way, that how the parahippocampal brain region was being removed, medial temporal lobe was being removed. As a result, he was facing a problem in the formation of new memory, leaving his old memory intact.

So, in these individuals also recall of the words are better if presented visually over the auditory way. So, in some instances what we have seen is that the once the information is

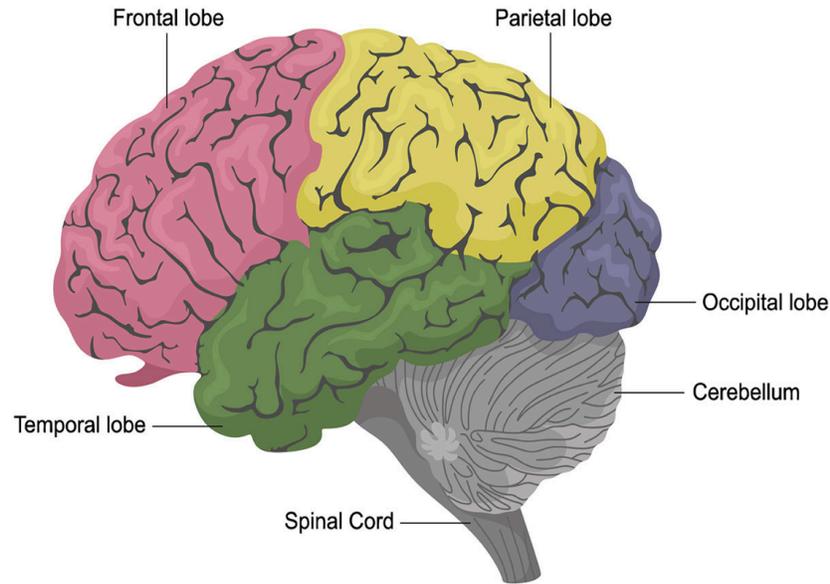
being registered in your system and it becomes independent of that structure, different parts of the brain tries to provide you cue internal cues because of this dense projection. So, any for the retrieval of the information, the not only visual area is required, but frontal cortex can also provide an integration. This reflects upon the associationalism. So, the association of information is happening in the brain and based on this association, the retrieval of information does not have to be entirely dependent on one brain region.

So, neuroimaging studies highlighted that the verbal working memory activates our right dorsolateral prefrontal cortex and the anterior cingulate cortex area. Verbal working memory, so frontal cortex is the site of central executive system which is receiving an input from the phonological loop brain region which is the Broca's area or the Wernick's area. So, both of these areas try to have projection from the, give the projection to the central cortex and this frontal cortex is getting an input from these different speech areas. Now the frontal cortex are of two different, are present on both sides. So left dorsolateral prefrontal cortex and right dorsolateral prefrontal cortex is there.

What we have seen in the case of the verbal working memory, right dorsolateral prefrontal cortex is playing major role over the other. Now, one should not have a misconception. The left dorsolateral prefrontal cortex is also showing an activation. It does not mean that it is passive in nature. It also shows an activation. However, the threshold of activation in the left side dorsolateral prefrontal cortex for the working memory will be little low in comparison to the right dorsolateral prefrontal cortex.

In addition to that, we have also seen some activation is coming at the anterior cingulate cortex. Anterior cingulate cortex is a reward and punishment system also. So it could be seen that when an individual is rehearsing the list of items, it could be rewarding that how many words one has remembered or rehearsed or it could be a form of a punishment also, so this area shows some activation. Then for the logical loop language related brain areas it is there especially helping in the production of these speeches. So when an individual is trying to produce.

So this brain region is lying in the temporal part of the brain region. So, temporal lobe is mostly being involved and you can see on your screen also this temporal lobe is actually



Source:

<https://www.hopkinsmedicine.org/health/conditions-and-diseases/anatomy-of-the-brain>

if you leave this side of the brain then is responsible in the language production and that is a lot of neuro stimulation studies you may find it that temporal lobe is being stimulated, Broca's area is being stimulated or Wernicke's area is being stimulated to improve the speech production or the stuttering problem The visual spatial sketch pad if you talk about right hemisphere with vision and spatial skills are being highly seen including the occipital lobe which is responsible for the all sorts of visual information. Here one has to see that the right hemisphere seems to have an important role towards the visual working memory and auditory working memory and integration of this information to the central executive system. Central executive system when we are talking about then we are talking about the both and whole frontal cortex area which includes the left and right side of the brain and also not only the dorsolateral prefrontal cortex but ventral medial prefrontal cortex and medial prefrontal cortex area.

So, frontal cortex is actually comprised of these three different brain regions here. Okay. So, what we see is that frontal cortex together, collectively is responsible for the central executive system. Now, this region is responsible for planning, monitoring and other executive functioning, integration of information and selection of the information per se. Let us talk about the application of short-term memory.

So, short-term memory or one could say the application of working memory. So, when we are talking about the working memory, initially also we have been talking about the measure and assessment tool. The measure and assessment tool and that task was the easy task for us to understand the integration of information, attention of an individual can be studied. So, the common paradigm which an individual is using for the working memory is the n back task. Here the two different tasks which you are seeing on your screen requires also the similar approach in the working memory processes.

If you talk about the reading fluency, then the information need to be holded in a system, in a working memory system for some period of time and when the information is being held there for some period of time, then only this information can be passed down to the central executive system for the further processing. So, what we see here, the connection between the working memory capacity and reading ability is there. what is an individual reading ability? Now this reading ability is an important, how many words one can hold in their working memory, how many words an individual can bind up in their working memory and how dynamically it can be allowed to switch and divide as we were discussing earlier in our discussion. So, once this is flawless, once an individual is having larger working memory capacity, reading fluency becomes better and better.

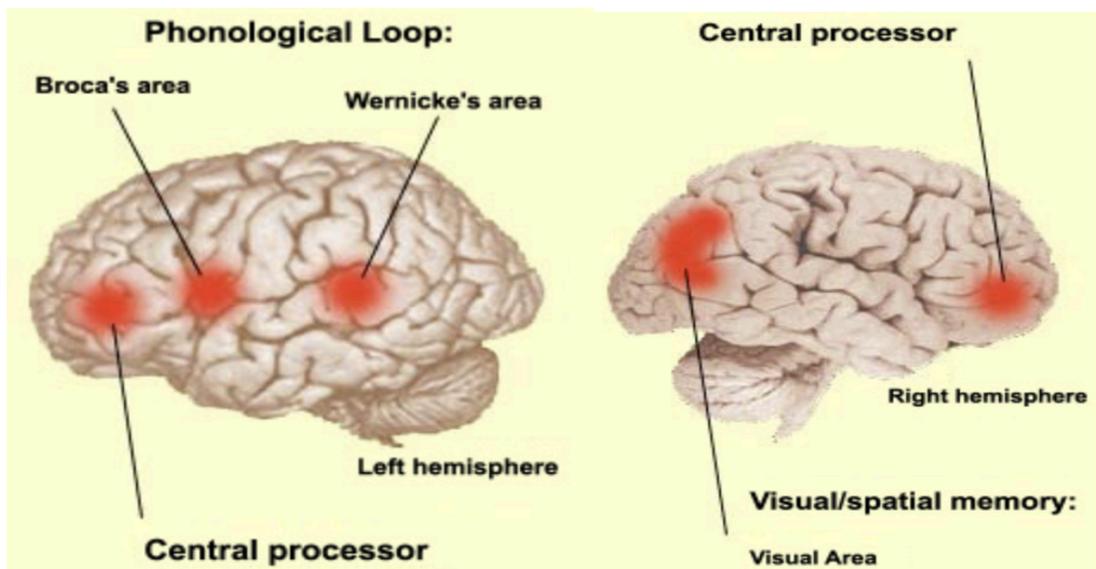
Now, this can be enhanced based on the practice. More and more reading an individual does, more and more information he can hold in his working memory. As a result, an individual can perform better and better. So, if a child can maintain more information in his or her working memory, you know, he can understand the material quicker with less looking back here and there. And that is why I think in school time, reading fluency teachers put lot of emphasis upon because once you are enhancing your working memory capacity, then the further knowledge, consolidation of further experiences become easier in your working memory system for a long term, which aids later to the long term memory for future reference.

Similarly, the verbal fluency is the ability to speak fluently without pauses. Now, in my lecture, you might have seen several pauses. The pauses reflect upon two things. First, the capacity of the working memory and then the integration of the two information together.

Violence, these pauses can be improved when an individual enhances his or her working memory capacity, one.

Secondary, the integration of the information, how quickly it is happening. Now this can be enhanced with a lot of practice. So verbal fluency is also one such tool which teachers try to introduce and make their pupils learn about this verbal fluency. More and more in individual talks, any topic or any concept or idea, this reflects upon the working memory capacity and the integration of the information between phonological loop, VSSP and episodic buffer together. So, a lot of haunts, haunts, pauses you may have seen.

Now, let us also talk about other than the So, other than the ADHD, sorry, other than the two important sections here, the point which we have to discuss about the ADHD. ADHD is the weaker working memory capacity. how this individual attention deficit hyperactivity disorder is there and these individuals seem to have a weaker working



Source: https://thebrain.mcgill.ca/flash/i/i_07/i_07_cr/i_07_cr_tra/i_07_cr_tra.html

memory capacity. Why these individuals have a weaker working memory capacity is because they are hyperactive, they are having more behavioral responses and they hold less information in their working memory. And the integration of these information is also lacking. Because we were talking about the working memory is having a central executive system which is an attentional system, these individuals lack the attention. So,

if you make them sit at one place and instruct them with certain instruction, they may not follow the instruction, they may not pay attention to those tasks and goals.

As a result, these individuals lack the ability and capability to enhance their working memory. Children with attention deficit also you know requires lot of practice training in the working memory task. More and more training is being provided to them. So, this enhances and increases their capacity about the working memory. Similar thing we have seen in a neurological disorder such as the Alzheimer's disease where we have seen that the neurological problem at the cortex affects the working memory capacity.

Now, this working memory deficiency could be because of a number of reasons. First is the neurological connectional damage, neurological and pathological problem related to the aging. As the brain is aging, it is dying, the neural connections are becoming weak and weak and this deficiency and this impairment actually affects and impairs the working memory capacity. Now, can it be diagnosed or identified early? That is a big challenge because this is a progressive disease.

We discussed about that the working memory is impaired in these individuals and these individuals; this individual was having a lot of problem with the working memory. The result was being impaired in the digit span task. He was able to retrieve the long-term memory information and also the new learning was intact. However, the working memory was a problem. We also saw that the working memory involves different brain areas.

Neuroimaging studies, PET studies gave us an insight about the integration of the Broca's area, Wernicke's area with the frontal cortex, visual area with the frontal cortex and how the integration and projection from the frontal cortex playing a major role. Impairment in any one of these areas could result into the dysfunctioning and impairment in the working memory. Reading fluency, verbal fluency are the tests which an individual were being using it to enhance the capacity of the working memory and the integration of the information with these tools an individual can overcome the challenges of the working memory capacity or the working memory integration information. We saw that the attention deficit hyperactivity disorder, these individuals have, because they lack the, they

have a deficiency and they lack the attention, the working memory system is being compromised because the attention system is being compromised. So in these individuals, a training, a practice can be provided to them which can be helpful for them to enhance the working memory capacity.

We also studied about the Alzheimer's disease, which is a progressive disease. What we have seen is that as the neurons are dying, as the projection between the neurons are being affected, the working memory capacity seems to be getting impaired and affected. So, a lot of other types of ADs there, like the frontopolar disorder, dementia, etc. are there. And we will be addressing this thing in detail in the coming lectures. I will stop here.

Thank you for your attention. We will start with a new topic in the next class.