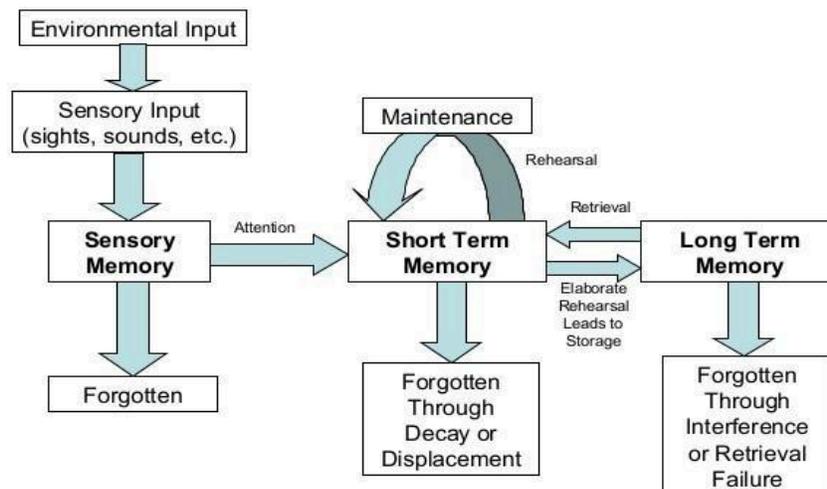


Memory
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Lecture 17
Working Memory - II

Hello, I welcome you all today in the lecture series of memory, working memory. As we studied in the previous lecture about the multi-store memory model, the stages of memory store model, the information processing model, the significance of sensory information, then the importance of short-term memory which we referred it as working memory. In addition to that, we also studied about the magic number 7 plus minus 2, George Sperling's detailed classical experiment and George Miller's detailed experiment. We even studied about the chunks, how the chunking is helping us to remember the information, large amount of information, its transference into our long term memory.



Now, in today's lecture, we are going to see the model proposed by Alan Baddeley.

As we discussed earlier also, why he recommended that short-term memory should be replaced with the working memory. So, if you see this model, the present model is not very different from the Atkinson Shiffrin multi-store memory model. Few addition, few modification has been made here, which is quite common. So, as you see here, the sensory memory is there. The incoming sensory information through the sensory system,

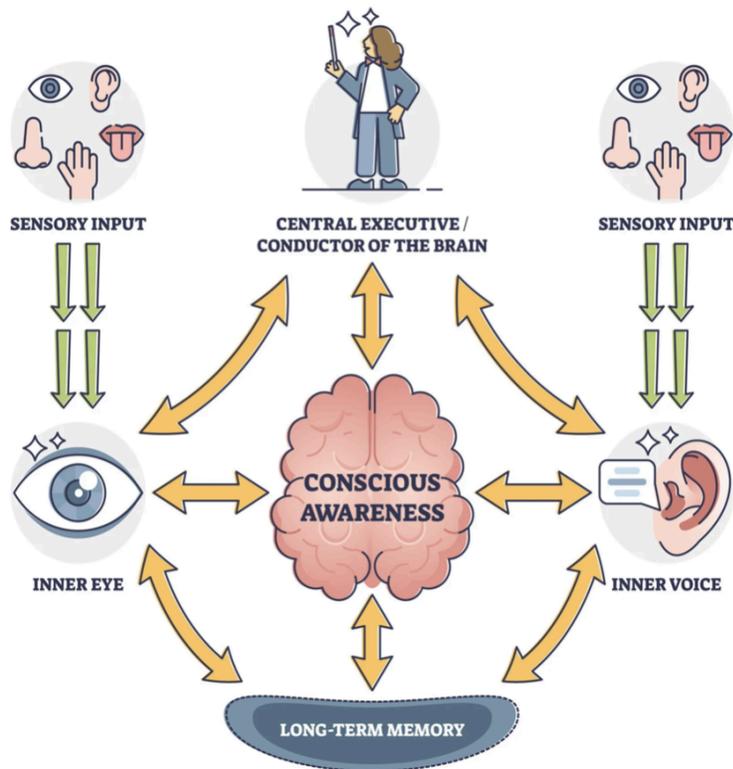
the amount of information which we do not process, leaves the system. When we pay attention to, it moves to short term memory. Upon rehearsal, the maintenance is done. More and more rehearsal makes the information robust and long lasting in the short-term memory system.

This information then moves to the long-term memory, and from the long-term memory upon retrieval upon this becomes labile again, and comes back to the malleable state that is the short-term memory state again. Now as we have been talking about this thing, Alan Baddeley conducted several experiments, gave several models related to memory. One such contribution, his major contribution was replacing the short-term memory with the working memory. Now, his understanding about the short term memory was that, it is very limited in nature and it is too simple in form. When in reality, there are multiple forms of memories, different types of memories are there, which are integrating with each other, fighting with each other, selection is happening, decision-making is happening.

In selection and decision-making, the memory which is more robust, the memory which is strong, leaves the impression and this is a very dynamic process. So this keeps on happening again and again and again. Another important element was that the information itself can be manipulated, can be changed at each and every state while in the case with the short-term memory it was not so. So, Alan Baddeley proposed that short-term memory should be replaced with the working memory. In addition to this, he also added the information that the contents which are involved at the time of consciousness are very active in nature. It cannot be so passive that a list of items could be rehearsed and it is based on the rehearsal, based on your maintenance of that rehearsal of the list, the information becomes long-lasting. He proposed that the working memory system is not one component, but it is comprised of different components.

Initially, he proposed these subcomponents or subsystems as slave system and these were three in number. As the time passed by, after 25 years, he proposed a new component into this list of components. The three components which he proposed initially in the year 1974 were visuo-spatial sketchpad, phonological loop and central executive system which is same as attentional system. Now, after 25 years, he realized that a system, a central executive system can process two information at the same time because, when we

are assuming, when we know that working memory is a very dynamic system, then in that case, it would be underestimating its potential and just understanding that only one type of memory processing will be happening. So, he proposed that more than one type of memory information processing can be executed at this system.



Source: <https://www.simplypsychology.org/working-memory.html>

Hence, he brought a new system that was Buffer, which was not only doing the selection of the information, but also ensuring the information transfer from working memory to the long-term memory system. So, separate working memory systems were there. Based on the different perceptual modalities, different type of memory systems were there. So if we study the system in little detail, so we will see that, there is a central executive system and this central executive system is through buffer sharing the information to the long term memory for a future reference. But the central executive system is receiving an input from the inner eye.

Or you could say as visuospatial sketchpad. All type of information related to visual information. Contrast, hue, saturation, shape, size, movement of object, spatial

information. Everything which has to do with visual processing is part of visuospatial sketchpad. And this visuospatial sketchpad, he referred it as visual working memory.

Another type of system he used was the inner voice or a phonological loop. Any type of auditory information, any type of information having auditory component or feature has been part of phonological loop. Now, this phonological loop, he referred it as auditory working memory, the working memory associated with all type of auditory information, and the visual memory associated with all type of visual information. Both these systems were receiving the input from the buffers. Both these systems were receiving an input from the sensory system.

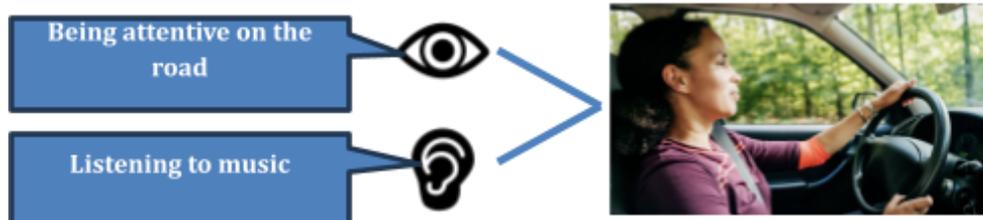
So based on the sensory system, there were some more additional components, such as tactile component, which is providing information to the central executive system about the tactile nature of the environmental stimuli. And along with tactile, then olfactory information, along with olfactory information, gustatory information, and many more such information were being presented. Then in 2001, Baddeley and Hitch added the buffer system. Then the idea was very simple that how the two information, auditory and visual information are going to be integrated. Initially, people assumed that there is no such integration happening between the two. Initially it was assumed, that only one information is going into the central executive system. Once the information is being processed, like visual processing, visual working memory information is being processed initially then only the auditory working memory information will be processed.

But this misconception, people started to rectify it and in 2001, we added the buffer system. The buffer system ensured that which information is going to be selected and which information after the selection is going to be passed on to the central executive system for further processing. Attentional mechanism coordinating between the two systems. One system was the central executive system and attentional system also ensured that the processing of central executive system is doing the inhibition, doing the selection, doing the division and such division, selection, inhibition were part of the attentional processes also. If you have to pay attention to, then you have to shift your attention.

If you have to attend to a stimuli, then you have to divide your attention between the different stimuli present in the environment. So, selection, division, shifting all were part of attentional system which is as equivalent as the central executive system processing. Now the four components, once we understood it, Baddeley and Hitch tried to address why these systems are seen as so distinct with each other, why auditory working memory cannot be same as the visual working memory and how the visual working memory is very distinct from the auditory working memory. So, to understand this clearly, he performed several experiments and with his finding, he observed that in the absence, he observed one thing, that when one system is being executed, then the other system is not participating. When another system is participating, then another system is not contributing at all.

What does this mean? So, he selected two groups of individuals and in one group, the individuals have to process the visual information. While doing the visual processing information, their target were to identify the visual processing, identify the visual targets. While they have to select the targets, visual targets among the visual information, the auditory stimuli were being presented to the participants. So the idea was that when the auditory stimuli is being provided to them, this auditory stimuli is going to interfere with the participant's visual search.

If this will happen, then one thing can be sure of is that the auditory system is having some interconnection with the visual processing system. Similarly, in another group, the auditory information were being presented and the target was to identify the specific nature of the sound. While doing so, the participants also do a visual processing task. So while the finding of this study revealed that when the participants were doing the visual search during the visual processing task, and the music was being presented as an interference, music didn't have any impact on the visual search. Similarly, when the auditory search task was being performed during the auditory processing stimuli, the



visual stimuli, visual processing, visual search didn't have any influence or interference with the auditory task.

So, seeing such dissimilarity between the two modalities, Baddeley realized that these two systems are independent from each other. To understand this better, Logie also did the similar line of research in 1986 when he encoded the associated list of visual imagery tasks and auditory processing tasks as well. The idea was that in visual imagery task, when the participants are seeing the words, they were interfered with the learning. So the sound was being played or interfered with. In the auditory processing task, hearing words interfered with the visual imagery task, suggesting that both perceptual working memory are adopting a different pathway, such as you can see while you are driving a car, you have to pay attention to the visual stimuli present on the road or present in the environment.

At the same time, when you play your music system and the music is being played, you can still hear the music and drive a car, ignoring the irrelevant stimuli present in the environment and selecting the relevant stimuli which are required for driving. So the visual information is a very distinct structure. Visual processing is very distinct processing than the auditory processing task. Moreover, in this direction, we also were trying to understand that the working memory task, the evidence for the working memory. Unlike the previous experiment, Peterson and Johnson took the digit span task and in this digit span task, the objective is very simple.

The participants have to recall the list of digit numbers presented to them in a correct form and in correct order. The accuracy and reaction time is the standard measures in such type of study. So 5 digit and as the performance get better and better, the series goes on increasing. So 5 digit, then 6 digit recall, 7 digit recall, 8 digit recall, 10 and 12. The digit recall can vary based on the researcher's design.

5-digit: 8 1 5 6 3
6-digit: 9 7 4 3 2 6
7-digit: 4 8 9 6 3 7 1
8-digit: 2 0 9 8 3 1 5 7
10-digit: 2 3 1 8 4 0 7 9 3 0

However, the main purpose of this design, or main purpose of this experiment is to check the attention span, how the attention system is being processed. Attention are of four different types basically. Attention is shiftable, attention is selective, attention is sustainable and attention is divisible in nature. So participants have to perform a digit span task. And participants just repeated the words over and over like 'the, the, the, the, the' while they were also supposed to rehearse the digits of the digit span task.

So digit span task is a very simple task. However, when they are executing and doing the two tasks, the repetition of simple word like 'the' should not interfere with the digit span task and that is the whole purpose of this experiment. And as per their assumption, the findings were also in the similar direction that because both tasks were different, both tasks were different but both tasks involved the auditory system. So repetition of simpler words, 'the, the, the' is not complex in nature. However, rehearsing and remembering the digit span task, speaking aloud and rehearsing it is also requiring the similar phonological system.

So what we observed is that concurrent task did reduce the number of digits that could be remembered. Which means recall of the simpler words like the the the is not supposed to interfere with the digit span task. However, it seemed that it affected the digit recall task. So this digit span task got affected by the repetition of simple word. The assumption behind this was that both systems are using the phonological loop.

Hence, one processing inhibited the other processing and vice versa. Of course, the degree of inhibition has not been investigated in such a study. But the nature of inhibition and the degree of inhibition may vary between the digit span task and repetition of simple word. We cannot rule out the fact that both system use the similar system for processing. This kind of interference is articulatory suppression because articulation has been used, and this is actually leading to the bad performance in the digit span task.

So articulatory suppression was being seen. So what did we study in this lecture? First point, we studied is that the contribution of Allen Baddeley and Hitch in 1974 replaced the short-term memory by the working memory. The reason for such replacement was

they proposed that working memory is dynamic in nature. It involves visual working memory.

It involves auditory working memory. And when more than two types of working memory system is involved, then it cannot be as simple as Shiffrin and Atkinson proposed in 1968. Secondly, working memory has various subsystems for major perceptual modalities. For major perceptual modalities, if you talk about. There are many perceptual modalities are there.

However, based on two sensory systems, visual and auditory, these perceptual modalities are there. Working memory composed of four different components. The fourth component has been added 25 years later, that is episodic buffer. The first three components, initial components are visual spatial sketchpad, phonological loop, and central executive system. Central executive system, he referred it as an attentional system.

The central executive system behaves in a similar fashion like the attentional system will work. Phonological loop, he referred it as phonological auditory working memory, while the visual spatial sketchpad, he referred it as the visual working memory. The evidences from the perceptual modality, the experiment done by Logie and the experiment done by Baddeley and Hitch reported and gave us an understanding that the different modalities are independent from each other. So auditory processing do not interfere with the visual processing and visual processing do not interfere with the auditory system. With this, I will stop here and in next lecture, we will continue with the working memory.

Thank you.