Working Memory

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According to Ricker, AuBuchon, and Cowan (2010), working memory is a cognitive system which is responsible for holding information temporarily for processing. An individual can access, evaluate and transform such information in the working memory into relevant cognitive behaviors or activities (Ricker, AuBuchon & Cowan, 2010). The important thing about working memory is that psychology knows little about it. In other words, the exact functioning of working memory has not been unveiled yet although it is considered as an integral part of short-term memory which is responsible for processing immediate perceptual and linguistic processing (Miyake & Shah, 1999). Some other scholars consider it as the notepad of consciousness (Orenstein, 2018). On the other hand, there are many scholars who still have doubts about the existence of working memory. For them, the existing working memory model is incapable of providing an exact description of the central executive functions. According to Scott-Taylor (2010), the working memory model has low experimental validity and it cannot be applied to real practical life problems (Scott-Taylor, 2010). In any case, what makes working memory an important concept in psychology is its strong association with intelligence. Moreover, any problems in the functioning of working memory would result in psychiatric disorders such as schizophrenia and autism (Orenstein, 2018). As mentioned by Gathercole and Alloway (2007), working memory has an extensive role in controlling cognition and it explains why different people have different cognitive capabilities (Gathercole & Alloway, 2007). In short, the understanding of the exact functioning of working memory would help medical science in finding out solutions for some serious mental, social, and behavioral disorders. Although there are plenty of debates and controversies regarding the functioning, it is believed that working

memory model is an integral part of short-term memory which is responsible for processing immediate perceptual and linguistic processing (Miyake &Shah, 1999).

Evidence for the Existence and Functioning of Working Memory

The concept of working memory was not well developed before the second half of the twentieth century although its connection with consciousness existed in theories. Studies conducted in the 1950s and 1960s tried to identify the association between working memory and short-term memory and how the short-term memory differs from long-term memory. These studies were successful in establishing the following concepts: 1)the maximum capacity of items that the short-term memory can store is seven (plus or minus two) chunks, 2) information can decay quickly form short-term memory if an individual fails to repeat it occasionally and 3) it is easy to access any type of information stored in short-term memory (Scott-Taylor, 2010).

In order to prove the existence and functioning of working memory, it is necessary to know how a person holds information in mind for later application after seeing or hearing something. Moreover, it is necessary to know how neurons in the brain's prefrontal cortex respond to such information. Lundqvist, Miller, and Pawel Herman (KTH Royal Institute of Technology in Stockholm) have conducted some experiments to know more about the aforementioned problem and found that neurons in brain's prefrontal cortex engage in spiking

and coordinated bursts, in brief, to store and retrieve information via the patterns of their connections. They argue that the coordinated bursts produce key attributes of working memory (Orenstein, 2018).

Baddeley and Hitch (1974) conducted a lot of experimental studies and has identified the central executive, the phonological loop and visuospatial sketchpad as the three major components of working memory. The Working Memory Model (WMM) proposed by Baddeley and Hitch (1974) can be illustrated as follows

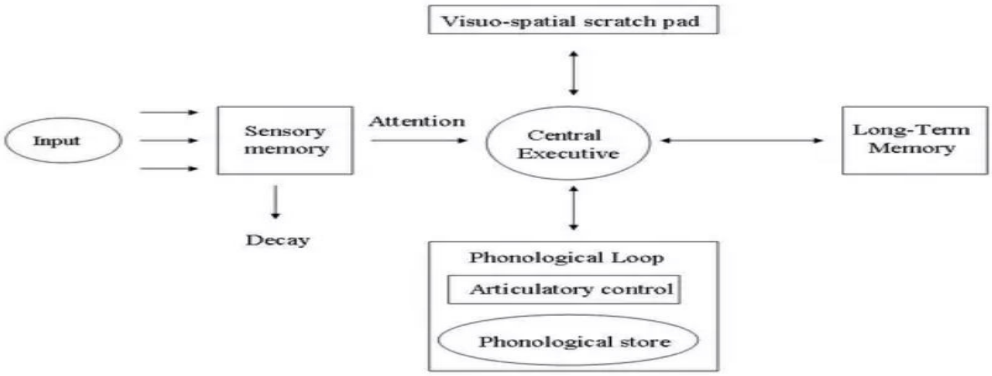

Fig. 1 The Working Memory Model (Baddeley and Hitch, 1974)

The proof regarding the existence of the aforementioned three components of the short-term memory emanated from an experiment conducted using the dual-task paradigm by Baddeley (2010). Using this technique, the researcher measured the performance of the respondents as they performed two tasks at the same time. During this research, the researcher observed that if the brain used one part to store both of the tasks performed, then performance would be slower and poorer compared to when the working memory used as two separate storages (Baddeley, 2010). The reason behind this analogy is the limitation of the short-term storage capacity.

Central Executive

As the name indicates, the central executive is the most important and versatile component of the working memory. As evident from figure 1 above, the central executive is similar to Central Processing Unit (CPU) of a computer. It drives the whole system by sending, receiving and processing information from the phonological loop, visuospatial sketchpad, and long-term memory. Moreover, it collects information from sensory inputs also. The central executive is responsible for the allocation of data to all the other subsystems in the working memory. It is responsible for executive functions such as mental arithmetic, problem-solving and decision making (Baddeley, 2012).

The central executive is instrumental in directing the attention of an individual from one task to another. It prioritizes different tasks which have to be undertaken by an individual. It serves as a monitoring center that controls the attention of individuals and aids them to plan and synthesize information from both the long-term memory and the subsidiary systems (Logie, 2011). Although the central executive has finite storage capacity, it is capable of processing information from diverse modalities (Baddeley, 2012).

Phonological Loop

The phonological loop deals with spoken and written materials. For example, phonological is loop is helping people to remember phone numbers, usernames, passwords, etc. It is capable of storing a finite amount of speech-based sounds for short periods. The phonological loop is usually divided into two parts: the phonological store which is capable of holding information regarding what a person hears and the articulatory process which helps people repeat words in a loop (Baddeley, 2010).

The phonological store can be considered as an inner ear which helps people hold information in spoken words for a couple of seconds maximum. While the spoken words enter the phonological store directly, the written words enter it indirectly. In other word s, written words will be converted into spoken words before allowing them to enter the phonological store. On the other hand, the articulatory control process circulates information round and round like a tape loop (D'Esposito & Postle, 2015). Students are usually advised to repeat learning the topics which are difficult to understand. The logic behind such advice is that people can retain information in the working memory for a longer period if they keep repeating it

Visuospatial sketchpad (VS)

The visuospatial sketchpad (VS) provides a virtual environment for physical simulation, calculation, visualization and optical memory recall (Baddeley, 2012). It is responsible for storing spatial and visual information. It is considered as an inner eye of the working memory (Logie, 2014). The VS helps in the arrangement and the manipulation of the images created mentally. Similar to the phonological loop, the visuospatial sketchpad has a finite capacity however; the restrictions entailed in the two components are independent (Logie, 2011). The last component added in the year 2000 when Baddeley and Hitch updated the model is the episodic buffer as mentioned earlier. This part functions as a backup responsible for supporting the communication between the other parts of the working memory and long-term memory (Baddeley, 2000). The information from VS can be used for purposes such as navigation. It should be noted that a lot of calculation, visualization and optical memory recall are necessary for navigation purposes.

Argument Against Working Memory Concept

Although the arguments in favor of the existence of the WMM are strong, there are some people who believe that the WMM model has some weaknesses. One of the major criticisms against WMM is that experiments failed to give clear evidence or descriptions to e lements such as the central executive. In addition, some of the experiments carried out in the model have low validity. That means the WMM cannot be applied to the real practical life of human beings (Scott-Taylor, 2010).

Conclusions

Although the WMM has few weaknesses, its strengths outweigh its weaknesses. The working memory is not a single system as suggested in the past. It consists of three major elements such as the central executive, the phonological loop and visuospatial sketchpad. The central executive is working as the CPU of a computer and controls all the information which were fed to working memory for processing from different sensory inputs, long term memory, the phonological loop, and the visuospatial sketchpad. It directs, monitors, and prioritizes different tasks and synthesizes information from both the long-term memory and the subsidiary systems. The phonological loop processes spoken and written materials. It is temporary storage which is capable of storing a finite amount of speech-based sounds. It has two parts: the phonological store and the articulatory process. On the other hand, the visuospatial sketchpad (VS) performs tasks such as physical simulation, calculation, visualization, and optical memory recall. It is recognized as the inner eye of the working memory. Mental images are stored in the working memory with the help of VS.

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