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THE HUMAN MEMORY

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Abstract: When we think about the world and its experiences, when we understand ourselves as beings that integrate a whole dynamic, we necessarily have to talk about memory. Well, all the information that was acquired through experimentation is stored in our memory. Humans are identity beings that shape themselves according to the experiences they experience directly or indirectly, and even more so they are the product of how they absorb and assimilate these experiences. We are human because we live and think about it, because we have the capacity to assimilate, feel and remember. This cognitive function is so powerful and so complex that it can even structurally alter the nervous system. This study aims to analyze memory, its functions and its structure.
Keywords: Memory. genetics. Learning. cognition.

INTRODUCTION

Memory is not an exclusive function of humanity, but it is in human beings that it presents its most complex degree, and its degree of sophistication is so great that it has the ability to cause structural changes in the nervous system.

Historically, memory has been the subject of much interest, especially by classical civilizations, but the first studies in the scientific field were only carried out in the 19th century, as were almost all sciences that involve the brain. We can say that only in the last hundred years has an understanding of the mechanisms of memory formation begun to be acquired.

> Diogenes of Apdonia, a Greek scholar, hinted at the relationship of memory to air, since, in his observations, he noticed that we breathe more easily after remembering a forgotten fact and that this process is often accompanied by the act of taking a breath. For Plato, memory would be analogous to a wax impression, kept as the event had occurred and, if it was lost, it was because this event had not really been experienced. Two thousand years later, William James takes up this Platonic analogy, stating that mnemonic impressions are not eliminated, even if the original information cannot be remembered by the subject at a given moment. (Neufeld et al, 2001)

However, it was not until the end of the 19th century (1885) that Ebbinghaus carried out the first rigorous experiments on matter. He was interested in how much information a person could remember and what strategies were used to achieve it.

One of his experiments focused on the memory of words. That is, he gave subjects a series of words and analyzed how much information they were able to retain after exposure. He quickly understood that when information (in this case words) had some binding meaning they were remembered more easily than when they didn't. Here comes a new question to be related to memory: meaning. When something is structured, it is stored much more easily.

However, over the years, several authors have focused on the matter bringing new information and creating various theoretical models about it.

MEMORY DEFINITION

Memory is the process of receiving information from the world around us, processing it, storing it and remembering it later, sometimes many years later. Human memory is often compared to that of a computer memory system or file cabinet..

But in reality, the memory is far from perfect - most people don't remember everything that happened to them, and memories are often altered and can become distorted. Memory is not just one entity - there are different types of memory such as: learning the meaning of single words, facts about the world, skills like learning to ride a bicycle or how to play a musical instrument, and a complex type of memory that allows us to remember and even 'relive' events or personal episodes from our past. This last type of memory forms our personal history or autobiography, which is why it is known as autobiographical memory. Several research teams have found that autobiographical memory is closely linked to another type of memory - spatial memory and navigation, which allows us to learn and remember how to find our way around the world. Furthermore, related to both navigation and autobiographical memory is the ability to think about events that might happen in the future.

However, defining memory in general and immutable traits is extremely difficult since information processing always depends on perception and, not being an isolated act, it is constantly influenced by emotions and even imagination itself. Authors such as Spear & Mueller (1984) patented a condensed definition of memory: "It is a multidimensional representation of an episode in an organism (and not a process)".

We can evoke memory as a more or less durable alteration of the organism's relations with its environment, which happens as a consequence of practice, experience and/or observation. All these changes take place through learning because it is through it that we have the ability to understand.

> Perception, in turn, requires not only coherence mechanisms, but also memory mechanisms, memory here also defined as a conscious prior knowledge of the object, which causes a lasting modification in the neural apparatus. It can be demonstrated by recognizing previous events or facts and remembering them (evoking them). Memories may or may not be permanent; however, we are not always aware of them. The representation of an episode requires that it be "perceived", "encoded", "stored" and that can be "revoked" (on the other hand, that can be "forgotten"), to use the most common expressions in this area. All these terms imply that the process is time dependent or time controlled. (CHAVES, 1993).

THEORETICAL MODELS

Many of the studies on memory differ on various issues, such as the way it works, the process by which information is retained and organized and its disposition. However, there are points of convergence in the way memory is formed and acquired. All models are unanimous in stating that memories are acquired through learning and that these need to be maintained so that there is a memory. After that, it is necessary to have an internal code that allows us to access them and recover them, that is, access the stored information. Memory storage is dependent on good encoding in order for information to be maintained and accessible.

SPACE MODEL

This model was presented in 1968 by Atkinson and Shiffrin and is based on information processing and was the first model to offer a systematic explanation of the structures and processes that make up the mnemonic system. The authors propose a tripartite model: sensory memory, short-term or primary memory, and long-term or secondary memory.

According to the authors, although we are exposed to a large amount of information, it is not all processed. in the case of **sensory memory**, its particularity is that the information remains for some time after the end of the stimulus, which assists in its further analysis (Eysenck & Keane, 1994). That is, these memories are available and remain for a reduced period of time and only collect material that has not been analyzed, that is, that is not consciously captured. Although this type of memory is related to all human senses, the study focused more on auditory (echoic memory, which lasts about 2 sec) and visual (iconic memory, which lasts about 50 msec) memories.

According to this model, this type of memory is processed very quickly and transferred in the form of results to a flexible and useful store: the **short term memory.**

This type of memory is characterized by condensing information and keeping it during the period that we are focused on that same information, that is, it is very limited. The particularity of temporality or flexibility of this type of memory made it called active memory or working memory, since we keep information only for the period in which we work with them.

In turn, the **long term memory**, it has a large storage capacity and condenses in it all the information about ourselves and our life gathered through learning and our experiences.

> The passage of information from short-term memory to long-term memory depends on some control processes. The memory control processes are: the repetition of information, the adequate encoding of information for long-term memory, the decisions we make regarding the importance of this information and the retrieval strategies or clues that will help when remembering it. (Neufeld et al, 2001).

MODEL OF THE TWO RECOVERY PROCESSES

This model contrasts memory access by recall and recognition. According to the model, it would be easier to remember something through a process of recognition than through a process of remembering, however the difference between them is that the process of remembering is deeply linked to two fallible stages: the search and the decision, being that by recognition, on the other hand, is only based on a fallible process: choice.

SCHEMA THEORY

This model refers to a type of cognitive heuristic that facilitates our understanding of our environment. They are mental concepts that are used to recognize and develop an understanding of otherwise complex objects and ideas, from recognizing people, animals, and objects in our immediate environment, to processing other types of information, such as how to behave. during a given event. Schemas also affect how memories are encoded and retrieved, supporting the theory that our memories are reconstructive.

In 1932, Bartlett proposed that our memory does not simply remember information about our surroundings, but that it is intrinsically related to the meaning we attribute to this information. Thus, memory would not be neutral in relation to experiences. In other words, everything that comes to us was reframed and coherently structured.

CODING OR CONTENT SPECIFICITY MODEL

This model was proposed by Tulving in 1982 and proposes that memory is divided into two: episodic and semantic. In episodic memory, autobiographical information would be stored, that is, memories about ourselves, about our childhood, about events in which the person would be the main character. In turn, semantic memory would be a long-term deposit that would contain general knowledge, linguistic knowledge and their meanings, as well as the rules for their use. In this model, there is a combination of stored information (knowledge) and remembered with information that can be retrieved and accessed according to what the surrounding environment transmits to us.

MANDLER RECOGNITION MODEL

In the early 1980s, Mandler proposed that recognition memory involves two distinct processes: familiarity and identification. The first consists of a memory signal, while the second involves the evocation of contextual and more detailed aspects of the memorized event.

> Thus, when an individual performs a recognition test for a list of words, for example, he can judge each word based on a sense of familiarity, just as he can make this judgment based on the evocation of specific aspects. experienced during coding (Illustration 1), such as what the individual thought or felt when he saw the word in the coding phase. This theoretical approach was especially supported by the asymmetry found in the ROC curves. Since this asymmetry is caused by a disproportionate amount of hits recognized with high confidence relative to false alarms recognized with high confidence, it can be assumed that underlying this effect is the recall process. That is, when items elicit the recall process, they are classified with high confidence. Like this, taking into account that a significant portion of the old items triggers the recall process, and that the recall is a process virtually absent in false alarms. (JAEGER, 2016).

DIFFUSE TRACE THEORY

This theoretical model was proposed by Reyna and Brainerd in the late 1990s and aimed to fill the gaps that previous theories had. This model is distinguished, mainly, for proposing intuition as the main metaphor for human cognition. According to this model, memory operates in a system of two distinct memories that would function simultaneously: literal memory (which stores superficial and specific details of the experience, coded episodically) and memory of essence (represents the meaning, patterns and meaning of the experience). lived experience). That is, when experiencing the same situation, literal and essence representations are processed and stored separately and, due to this factor, the fragmentation of memory traces can produce the dissociation of aspects of the same experimentation.

> The two memories also differ in the content of their representations. Literal memory represents the surface and specific details of the experience, encoded episodically. The memory of the essence, on the other hand, represents the meaning, patterns and meaning of the lived experience. For example, a literal representation would be to remember that a certain person told us about a yellow gold dress, with blue buttons, that he saw in a window. The representation of the essence would be to remember that this person told us about a piece of clothing, but not exactly if it was a dress, a blouse, a skirt, etc.
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> (Neufeld et all, 2001).

MEMORY AND THE NERVOUS SYSTEM

The central and peripheral nervous systems control information processing associated with cognition and behavior and the transmission of information to/from sensory and effector organs, respectively. Memory, which is the process by which information is encoded, stored, and retrieved, has been extensively studied from the molecular level to the whole organ level. The memory function is managed by multiple parallel neural systems across multiple spatio-temporal scales. Recently, neuroscientific data measured by various methods begins to be collected to organize large databases. New using these data may provide a deeper understanding of information processing in the nervous system. Computational theory is expected to play a dominant role in the integration of memory data with knowledge gathered in other scientific domains. Memory is not stored in one place in the brain. It is distributed in different parts of the brain. This does not imply that all regions are identically

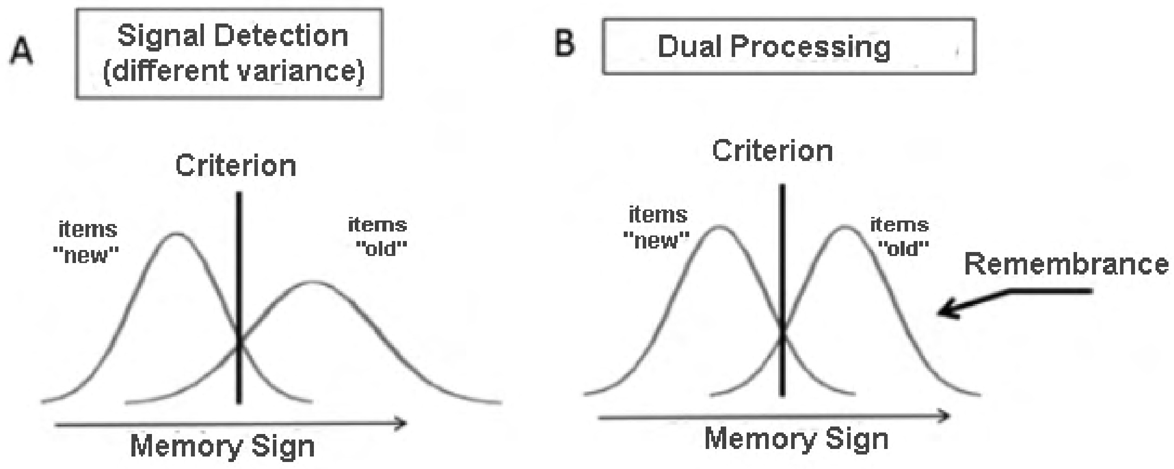

Illustration 1-Signal detection model with different variance and dual processing model. Image available at: DOI:10.1590/1413-82712016210309

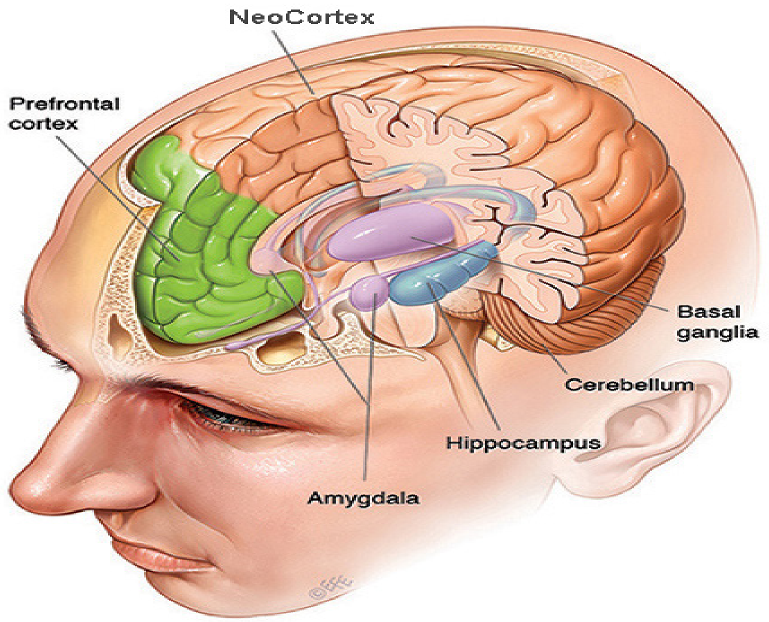

Illustration 2 – Parts involved in memory. Levent Efe's image involved in storing information: different areas store different aspects of memories.

> It is believed that the engram of a declarative memory is distributed among different brain regions, and that these regions are those specialized for certain types of perception and information processing. This distribution of memories in different brain regions also depends on the type of memory and the time elapsed after the acquisition of information. In the case of inhibitory avoidance task memory formation, which has been one of the experimental paradigms in rodents, evidence implies the activation of AMPA receptors (one of the receptor types for glutamate, an excitatory neurotransmitter) in the hippocampus during the first three hours after training. A chain of biochemical events is triggered in the hippocampus and, shortly thereafter, several structures in the cerebral cortex are also activated. (DALMAZ et al, 2004).

The limbic system is composed of the piriform cortex, hippocampus, septal nuclei, amygdala, nucleus accumbens, hypothalamus, and anterior thalamic nuclei. The fornix and fibers connect parts of the limbic system allowing them to control emotion, memory and motivation. The piriform cortex is part of the olfactory system and is found in the cortical area of the limbic system. Different types are stored in different interconnected brain regions. For explicit memories - which are about events that happened to you (episodic) as well as facts and general information (semantic) - there are three important areas of the brain: the hippocampus, the neocortex and the amygdala. Implicit memories, like motor memories, depend on the basal ganglia and cerebellum. Short-term working memory relies more heavily on the prefrontal cortex.

The hippocampus, located in the temporal lobe of the brain, is where episodic memories are created and indexed for later access. Hippocampal formation influences new memory formation and memory consolidation. This section of the brain also influences our ability to encode and retrieve information - where a short-term memory is recorded before being transferred to long-term memory storage. Axons in the entorhinal cortex carry information in the hippocampus, which sends signals to neurons in pyramidal cells at the opposite end. These neurons are divided into two pathways: the polysynaptic pathway, the part of the hippocampus responsible for learning and memorizing facts and concepts, and the direct pathway, which is important for event collection and spatial recognition.

We have this information because in 1953, a patient named Henry Molaison had his hippocampus surgically removed during an operation to treat epilepsy. He was cured and lived another 55 healthy years. However, after the surgery he was only able to form episodic memories that lasted minutes; he was completely unable to permanently store new information. As a result, Molaison's memory was mostly limited to events that took place in the distant past. However, he was still able to improve his performance on various motor tasks, despite having no memory of ever having encountered or practiced them. This indicated that although the hippocampus is crucial for the establishment of memories, it is not the permanent storage location of memory and is not necessary for motor memories. Henry Molaison's study was revolutionary because it showed that there were multiple types of memory.

Damage, deterioration, or underdevelopment of the human hippocampus can lead to many brain diseases:

1. **Alzheimer's disease:** In people with Alzheimer's, neurogenesis (the creation of new neurons) is inhibited, and important cells and connections die, leading to memory loss and impairment, and other mental dysfunctions.

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2. **Amnesia:** Damage to the hippocampus can affect a person's ability to recall explicit memories, such as names, dates and events, and affect their ability to imagine future experiences, also called anterograde amnesia.

3. **Epilepsy**: The researchers found that between 50 to 75 percent of epileptic people who received post-mortem autopsies had damaged hippocampi. Although advances in neuroscience have led to important insights into epilepsy, scientists are not sure whether epileptic seizures are the cause or effect of hippocampal damage.

4. **Schizophrenia**: Abnormal structure, reduced size of the brain and hippocampal neurons, and decreased expression of essential genes and proteins have been observed in those with schizophrenia.

5. **Depression**: People with depression are more likely to have a smaller sized hippocampus, along with a reduction in the size of the cornu ammonis, dentate gyrus, and subiculum, which are key subdivisions of the hippocampus structure.

6. **post-traumatic stress disorder**: Post-traumatic stress disorder is closely related to a person's memory and experience of a traumatic event. Individuals with PTSD may not remember certain traumatic moments in their past or find that their trauma memories are always present. This constant stress triggers the release of cortisol - the "fight or flight" hormone that signals the body that we are in danger. Elevated levels of cortisol can negatively affect the hippocampus.

The neocortex is the largest part of the cerebral cortex, the "sheet" of neural tissue that forms the outer surface of the brain, distinguished in higher mammals by its wrinkled appearance. In humans, the neocortex is involved in higher functions such as sensory perception, generation of motor commands, spatial reasoning and language. Over time, information from certain memories that are temporarily stored in the hippocampus can be transferred to the neocortex as general knowledge. The researchers think that this transfer from the hippocampus to the neocortex happens while we sleep.

The amygdala is an almond-shaped structure in the temporal lobe of the brain that is responsible for giving emotional meaning to memories. This is particularly important because strong emotional memories are hard to forget. The permanence of these memories suggests that interactions between the amygdala, hippocampus and neocortex are crucial in determining the 'stability' of a memory - that is, how effectively it is retained over time.

There is a complementary aspect to the amygdala's involvement in memory. The amygdala not only modifies the strength and emotional content of memories; it also plays a key role in the formation of new memories specifically related to fear. Fear memories are capable of being formed after just a few repetitions. This makes 'fear learning' a popular way of investigating the mechanisms of memory formation, consolidation and recall. Understanding how the amygdala processes fear is important because of its relevance to post-traumatic stress disorder (PTSD), which affects many military personnel, as well as police, doctors, and others who deal with trauma more frequently. Anxiety in learning situations is also likely to involve the amygdala, and can lead to avoidance of particularly challenging or stressful tasks.

The prefrontal cortex is the part of the neocortex that lies at the very front of the brain. It is the newest part of the mammalian brain, and is involved in many complex cognitive functions. Human neuroimaging studies using magnetic resonance imaging (MRI) machines show that when people perform tasks that require information in their short-term memory, such as locating a light, this zone becomes active. There also appears to be a functional separation between the left and right sides: the left is more involved in verbal working memory while the right is more active in spatial working memory.

FINAL CONSIDERATIONS

The question of memory has always been studied, but it is only now that we begin to understand all its intricacies. One of the most important questions is due to the fact that it has been understood that several areas of the brain are involved in its creation and maintenance, just as memory is closely linked to learning and intelligence.

Memory storage depends on attention and emotion deposited to the intensity required for storage. We are an organism that values survival, so the emotional impact that puts us at risk elevates the priority to memories of fear. The evolution of the prefrontal cortex has helped to store more complex and risk-free memories.

The synaptic strength interferes with this memory storage and, therefore, memorization techniques can be conditioned according to the individual's experience and particularities. Consolidation of memory and its retrieval is related to need and routine. Reinforcement in engram cells are re-marked clues when reliving memories. Consolidating with greater clarity, but being able to distort the original memory according to the new experiences, this does not mean that in a totally different way, but who knows with some small changes.

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