
NEUROPSYCHOLOGICAL HISTORICAL DEVELOPMENT STUDY OF MEMORY

Jorge Luis Chapi Mori
Universidad César Vallejo


La correspondencia relacionada con este artículo debe dirigirse a Jorge Luis Chapi Mori, e-mail: jorgelchm@gmail.com. Universidad César Vallejo, Av. Larco 1770 – Distrito de Víctor Larco Herrera.
NEUROPSYCHOLOGICAL HISTORICAL DEVELOPMENT STUDY OF MEMORY

Jorge Luis Chapi Mori 1
Universidad César Vallejo

ABSTRACT

The purpose of this review is to mention the importance of interest and research on cognitive processes in the history of the neurosciences, in this case the memory. From a neuropsychological perspective, the first considerations about memory up to the contemporary scientific study are detailed. So, the theories of neuroscience and their direct or indirect application in people’s daily life due to the contributions of this set of scientific disciplines are related.

Keywords: history, memory, neuropsychology, neuroscience

DESARROLLO HISTÓRICO DEL ESTUDIO NEUROPSICOLÓGICO DE LA MEMORIA

RESUMEN

El propósito de esta revisión es colocar en relieve la importancia del interés e investigación de los procesos cognitivos en la historia de las neurociencias, en este caso la memoria. Se detalla, principalmente mediante una perspectiva ligada a la neuropsicología, las primeras consideraciones en torno a la memoria hasta llegar a conocer el estudio científico actual, donde confluyen aspectos teóricos ligados a las neurociencias junto a la aplicabilidad directa o indirecta en la vida diaria de las personas gracias a los aportes de este conjunto de disciplinas científicas.

Palabras clave: Historia, memoria, neurociencias, Neuropsicología

1. Psicólogo con especialidad en Neuropsicología, docente de la Universidad César Vallejo. Correspondencia: jorgelchm@gmail.com - ORCID/O0000-0002-5976-4158
DESENVOLVIMENTO HISTÓRICO DO ESTUDO NEUROPSICOLÓGICO DA MEMÓRIA

RESUMO
O objetivo desta revisão destaca a importância de interesse e investigação de processos cognitivos na história das neurociências, na memória neste caso. Ele é detalhado principalmente por neuropsicologia às primeiras considerações na memória até que seu estudo científico contemporâneo e aspectos teóricos da neurociência relacionadas a dirigir ou a aplicação indireta na vida diária das pessoas graças às contribuições deste conjunto é detalhado de disciplinas científicas.

Palavras-chave: história, memória, Neurociência, Neuropsicologia

In the field of neurosciences, it is inescapable to talk and to investigate the neurophysiological and anatomical aspects of psychic processes. There has always been the desire in man to discover and learn more about how he talks, his memories and other acts linked to thought and mental activity are included. And recalling the first thinkers, especially in the flourishing period of Greece and Rome, you may notice that one of the mental processes highly valued by who cultivated it as a form of training and expression was memory. As Finger (1994) points out, this ability to record, store and recall information was synonymous of high capacity for judgment, understanding and perfection. It is Plato describing what Socrates wanted to explain in his "Theaetetus" dialogue about memory, referring to it with metaphors of the impression left by the pressure on wax tablets, where memories are strong and pure when the wax allows, in this case when there is biopsychological ability to encode and recall information, and otherwise mentioned the figure of the bird and the large cage with several compartments, where it represents learning and knowledge as possession and availability to catch all possible bird in the cage, while specific stores symbolize forms of memories or experiences themselves, because these are the properties of these birds; that is, the more birds, and better control of these, the better the knowledge and learning, both obtained through the memory. In that time after Plato, the idea of Aristotle will be important to learn more about memory, he meant that this is something of the past, what has already happened, and those memories are attainable if one refers a starting point or associated ideas for finding what is sought; memory then becomes part of the soul, the essence itself, and imagination (Suarez and Zapata, 2006).

Another important figure of this period, in Rome influenced by Greek culture, was Galen who stated that the powers of the soul are made and have as headquarters to the cerebral ventricles containing the psychic pneuma or "spirit"; therefore, in that aspect of memory, which was already considered as the main agent of thought, is the functional link in forming mental images, judgment, opinion, and the evocation of these images (Manzoni, 1998).

During the Middle Ages between the fifteenth and sixteenth century, conceptions about the soul and what is daily now known as "mental" were
changing with new explanatory models, memory was not immune to it, and in this period the figure of René Descartes highlights when analyzing this soul is channeled through nerves or tubules to their specific compartments (valves) enabling operation of all expressive form in the human body. Such specific cavities suggest which corresponds to the storage system and mnemonic operation. After this period, many thinkers maintained, with some variations, Cartesian ideas that strictly segmented between a soul (causes the function) and the body, giving rise to an explanatory dualism of existence of being (Finger, 1994; López-Muñoz Marín & Alamo, 2010).

In the late seventeenth century, in England, Thomas Willis approaches a systematic study of memory and believes at first that the accommodation is in the cerebellum, then reconsidering that this itself contributes to this process, but gives more importance to cerebral cortex, specifically the turns of the cerebral hemispheres; at the same time he stressed that the aforementioned alterations in brain structures are linked with mental deficiencies (Molnar, 2004).

During the nineteenth century, Ewald Hering made an incursion into areas that seemed the exclusive domain of speculation regarding memory functions through his treaties of physiology where he talks about the importance of memory, which in summary is a highly organized function of matter. In the mid-nineteenth century, the American philosopher William James popularized the terms primary memory and secondary memory, which are the current equivalent of short and long term memory, respectively. In Germany, at the end of the century, the psychologist Hermann Ebbinghaus pioneered objectively in studying the capacity of memory or memories; he attempted to formulate fundamental laws of human memory with experiments. He made his experimental studies based on reproduction or repetitions with different forms based on verbal, numerical units and geometrical figures, ranging from the simple, such as syllables to poems. With these studies, he did not only hope that he could work in understanding the nature of learning and forgetting, but also he had a practical value in the field of education (Gilman & Winans, 1994, Montealegre, 2008).

In the early twentieth century, the figure of the French Mathias Duval was important to promote the cell study of brain functions, adhering to the proposals of Ramon y Cajal about neuronal study; in that sense, memory did not escape of this study, encouraging greater understanding after the contribution of the Russian physiologist Ivan Pavlov who laid the explanatory basis of learning explanations, based on the physiological memory trace, meaning from this level that all the machinery can be explained by the memory in complex mental processes. Then, in 1900, an event occurred that would lead almost all current research on neurobiology and neuropsychology of memory, in which the German psychologists George Elias Müller and Alfons Pilzecker conducted the first experiments whose purpose was to identify the laws governing the establishment and memory recall whose main conclusion reported in forty works was that setting progressive memory requires time and memory is vulnerable mainly during the consolidation period.
Throughout the history of scientific study of memory, especially in modern times, some theorists have pointed their structural studies, while others have set their interest in functional memory systems, where they focused on the study of brain damaged or disorders and also the functioning of the healthy brain, where the importance of cognitive psychology, the forerunner of theoretical models and experimental cognitive neuroscience (Aylward, 2002; Benedet, 2002) would be appreciated. At mid-twentieth century, a momentous event in the study of memory came from the observation of the neuropsychological disorders of this function resulting from surgical or traumatic injury to the temporal lobe, specifically Canadian studies by psychologist Brenda Milner, who liked the neurologist Wilder Penfield, they reported cases that later helped to systematize the organization and structure of memory, and it is known the famous case "H. M." in the observations of Milner, his hippocampus was removed to calm his problems -- he was treated by the American doctor William Scoville -- and lost a large part of his functional communication, in several aspects, but especially the fixing for long-term memory, and whose main sindromology is now known as anterograde amnesia, being better the conservation of his mnemonic skills for psychomotor skills or the so-called procedural memory (Scoville & Milner, 2000); however, in the light of contemporary findings in 2009, Jacopo Annese and his research team were able to analyze the brain of one of their patients and was determined that the entorrinal cortex was the most affected in this surgery, so this brain structure is linked to the memory impairment of the early stages of Alzheimer's disease (Annese et al., 2014). At the same time, in the first half of the twentieth century, the English psychologist Donald Eric Broadbent raised the first structural model of information processing in the cognitive system. This model represents the first diagram showing how information flows through the system of information processing and what happens to the information served and unserved. In the same line of cognitive explanation, American psychologists Richard Atkinson and Richard Shiffrin, in 1968, proposed the structural model because it emphasizes the existence of various structures or different memory stores affecting the functional dynamics of each type of memory.

In the seventies of the twentieth century, psychologist and Russian neuropathologist Aleksander Luria, in his scheme of explanation of neuropsychological activity, based on studies in patients with brain damage, indicated that memory is a complex activity that works as an interacting factor between the income of sensory information and the production or execution of higher mental functions; therefore, the memory is no longer seen as a warehouse or structure of sectors and the model of functional system is strengthened and that will be always influenced by factors such as motivation, training and retention of a purpose, with the election of a proper plan and all the operations necessary to perform it. He also unveiled an important clinical series of cases in explaining different amnesic syndromes (Luria, 1977, 1988). Moreover, cognitive neuropsychology granted, in the beginning, great importance to the
storage models and their relation to different types of memory, especially short-term one which keeps information active. And although this was a fairly widespread perception, cognitive psychologists were the ones who initiated and better developed the concept of information processes, including one of the precursors as Frederic Bartlett, British experimental psychologist who was interested in studying the thinking and memory, and later George A. Miller, who in 1951 with his work entitled "The magical number seven, plus or minus two" decided to describe the limits of human ability to process stored information, whose standard warehouse ranges from five to nine units or chunks information (Vítores, 2010; Miller, 2003). Later in 1974, the British cognitive psychologists Alan Baddeley and Graham Hitch studied in depth how memory works during a memory specific activity; that is, how it starts and how it runs, this form was called working memory (Baddeley, 1986). Expected in line with the hypothesis of working memory was the realization of an alternate or secondary activity requested to produce a significant decrease in performing an initial cognitive task. Thus the neurocognitive study of memory in this century was determined because of the vast influence of cognitive psychology and the various theoretical approaches to explain the different mental processes. (Ballesteros, 1999)

Getting closer to current neuroscientific studies, it is evident that during the last half of the twentieth century, the interest in correlative anatomical studies was revived, with new visualization techniques and further development of the techniques of magnetic resonance imaging and positron emission tomography, so the anatomical study of cognitive processes in patients was supplemented both sick and healthy and intact patients. Although everything did not focus on the structural analysis of memory, it is important to note that one of the most important studies on the mechanisms of mnemonic process was carried from the biological perspective, specifically at the molecular level as that of Erik Kandel who made a neurobiological study in the animal species Aplysia, chosen due to having long axons, then he won the Nobel prize in 2000 for his explanatory study of neuroplasticity which is based on the memory in the process of learning and experience whose research was linked to understanding of various disorders that had already been studied but from semiológical and clinical field (Kandel, Schwartz & Jessell, 2000). In this way, in the lights of current neuroscience, there is a vast evidence about memory, that information from a learning experience could remain stored under changes in the structure and neuronal metabolism, such as dendritic growth, genesis of dendritic spines, increased production and release of neurotransmitters, synthesis of receptors sensitive to specific neurotransmitters, among others that are limited to the molecular level and are perceived as behaviors at individual level, this being beneficial to further entrench basic concepts in neuropsychology which thrives on such information (Prado-Alcalá et al., 2006).

IMPLICATIONS OF BRAIN ACTIVITY IN MEMORY OPERATION

Then it is found that memory, throughout history, has been the center
of importance to know about learning, memories and experience. In that sense, it is necessary to know that memory, in the current context of neurosciences, is the neuropsychological process that allows you to record, encode, consolidate, store, access and retrieve information, thus constituting a basic process for adaptation of the human being to the world around it (Eichenbaum, 2003). Therefore, learning and memory are correlated processes capable of modifications based on environmental stimuli. From an empirical point of view, it is not possible to separate memory from learning, but pedagogically and didactically in order to better understand the cognitive processes, it can be made a theoretical distinction for a greater differentiation. Meanwhile psychophysiologically, the mnemonic process is carried out at the biochemical and metabolic levels in cortical and subcortical brain structures (see Figure 1), although the importance of consolidating memories is mainly set in basal or subcortical structures, the cerebral cortex is the one that ultimately allows the selection and organization of those memories, including linkages with prospective life; i.e., with future plans concerning to planning and awareness of personal action (Ardila & Moreno, 1979; Mecklinger, 1999; Ortiz, 2004).

![Figure 1. Cortical and subcortical structures involved in memory processes seen from a coronal section.](image)

Las estructuras cerebrales The brain structures involved as a starting point and basic and elementary memories in life are below the cortical formation; at the level of phylogenetic evolution, a great activity of structures such as the hippocampus, which consolidates the information and currently adds the sustainment -at the cellular level and functionally- of cognitive maps or basic guidelines included in the spatial orientation as referred to Nobel Prize of Medicine 2014 Jhonn O'Keefe and husbands May-Britt and Edvard Moser (Hartley, Lever, Burgess, & O'Keefe, 2014). Other subcortical structures such as the amygdala also play important roles in memory, this structure has implications with locking emotional memories and starting of motivation (Rabinak & Maren, 2008). Also, the basal ganglia are very important in some specific types of memory, such as motor, this in turn is part of the procedural memory, being nondeclarative or implied and automatic, which together with cerebellar functions allow people to perform psychomotor activities under a known pattern that is consolidated with the experience and feedback such as writing or riding a bike. The role of
other structures such as the cingulate is that the linking with cortical structures be much more intimate and therefore it makes a thin line of relationship between past and recent memories be generated. Under this view, then, the neocortex or isocortex which is the phylogenetic structure that has evolved considerably, unlike subcortical structures, is the one which will allow the organizing and distributing of more specialized, explicit and integrated memories (Valverde, 2002). Brain lobes of posterior regions, as mentioned Luria (1988, 1977), are those that have to do with information acquisition and storage, mainly conscious, especially the medial temporal cortex of great contribution to the activity of operational memory or work in line with the prefrontal cortex much studied in macaques and humans (Milner, 1970; Pesaran, Pezaris, Sahani, Mitra & Andersen, 2002). In these posterior structures, learning is configured as a perception or gnosia as interpreting sensory memories, and being associated with brain structures above, in this case the frontal lobe, which will allow to organize and achieve some of the more complex psychic functions of human beings, the language, and in this respect the memory do not only encode sensoperceptual and motor information, but also involve significant aspects in people’s life, so you can consider a planning and executive memory involving an intrinsic relationship with the thought and the awareness of self and the reality in which the individual is. (see figure 2) (Kolb & Whishaw, 2008; Ortiz, 2004)

![Diagram of the lateral cerebral cortex and view of the specific operation of memory processes.](image)

*Figure 2. Diagram of the lateral cerebral cortex and view of the specific operation of memory processes.*

Note: Regarding the citoarchitectonic the Brodmann map, motor (red) and associative (white) sensory areas (blue) being in the latter where more complex types of memory are processed appreciated. Taken from Fuster, 2010.

**EXPLORATION OF MNEMONIC PROCESS TODAY**
Nowadays, the functional study of memory is related to the neuropsychological evaluation techniques, with handling of physical materials, pencil and paper, digital and computerized neurological examinations by physiological and imaging techniques, positron emission tomography (PET), which performs the mapping of cognitive functions such as attention, memory and language. Also the Single Photon Emission Computed Tomography (SPECT) which finds mnemonic difficulties and is very useful in the diagnosis of Alzheimer's disease and dementia cases. On the other hand, the cerebral angiography becomes important in giving information about the cause of memory loss at the level of blood flow. However, with the technique of functional magnetic resonance imaging (fMRI), a lot of research of some types of memory has been done, such as working memory, being observed in this case the activation of the ventral and front portions of the lateral prefrontal cortex. Activation of additional areas in memory such as premotor cortex, parietal lobe upper portion and thalamus has been found suggesting the existence of more complex networks. It has also been studied the process of remote memory by investigating the facial recognition where the temporal and occipitotemporal cortex participate. Regarding the lateralization of memory functions, there are bilateral activations in mesial temporal areas including parahippocampal areas and the hippocampus. Moreover, the rise of research in cognitive neurosciences is using the correlation neuropsychological assessment and brain bioelectrical activity using cognitive evoked potentials or related events, which are electrophysiological measurements often reflected as amplitude of P300 wave, related to cognitive functions which were studied especially in attentional and memory processes (Chapi, 2011, 2013; Gutierrez, Rangel & Tovar, 2013; Snell, 2007; Gironell Garcia-Sanchez-Gonzalez Estevez, Boltes & Kulisevsky, 2005). In that sense, all these techniques facilitate neuropsychological memory research both structural and functional brain, with the range of studies ranging from learning the activity in healthy brains (See Figure 3) to clinical syndromes. (See Figure 4)
Desarrollo histórico del estudio neuropsicológico de la memoria

Figure 3. Magnetic Resonance Images (MRI) of lateral view of brain and its relation to areas involved with memory.

Note: In the image to the left, the anterior or anterior prefrontal cortex (APFC), the dorsolateral prefrontal cortex (DLPFC) and ventrolateral prefrontal cortex (VLPFC) is observed. Behind the central sulcus, it is shown the posterior parietal cortex where the upper posterior parietal cortex (UPPC) and the lower posterior parietal cortex (LPPC) are located; the intraparietal sulcus (IPS) divides the UPPC and the LPPC. Towards the temporal region, the superior temporal gyrus (STG) and the supramarginal gyrus (SMG) are observed. In the figure to the right, you see the middle temporal gyrus (MTG) including the hippocampus; whereas towards the posterior region, the occipital cortex (CO) is shown. Taken from Ruiz-Contreras and Cansino, 2005.

Figure 4. Areas of brain activation related to visuospatial memory using functional magnetic resonance imaging (fMRI) with axial cutting in people with and without clinical syndrome.

Note: Images from a healthy patient (upper images) and with left temporal lobe epilepsy (LTLE) (bottom images). This study involves two neuropsychological tasks: first, the memories of images (a, c) and the second one about spatial orientation memory (b, d). Note in the first task with healthy subjects, mesial temporal areas are activated bilaterally after (a); while in the second task, parahippocampal areas (b) is mainly activated. On the other hand, in subjects with LTLE for both tasks (c, d), similar and adjacent areas are diffusely activated while improving activation of counter-injured side. Modified by Sanjuan, Villanueva and Avila, 2008.

Final Comment

It is mentioned that in relation to memory and brain activity, the different
brain structures do not work independently to activate the most complex mental functions such as perception, praxis, language, thinking, decision making among others. This occurs at the cellular level as engrams and circuits in conjunction with cortical and subcortical structures, mainly through a complex network system; i.e., cortico cortical, commissural and projection fibers, which are the output of each module to other specific cortical or subcortical areas; thus the cerebral cortex controls higher mental processes with direct involvement of memory and feeding back by way of information the various forms of activity both at the molecular level and the implications of the role of social media, not only in complex acts but also in perceptual and motor activities that are vital in the early stages of life.

In this new current neuroscientific perspective, it is important to highlight important researchers such as Rita Levi Montalcini, Stanley Cohen, Daniel Kahneman, among others, who contributed and contribute with all that is now being studied in neurosciences and linked to social reality, so in practice, the findings give rise to mention with support that its applicability in other disciplines such as education, anthropology, among others, effectively affects the quality of life of people suffering from disorders of forgetfulness, amnesia, dementias among others, even for those who make important decisions at the level of their daily and social life.

REFERENCES


Chapi, J. L. (2013). Utilidad del test psicométrico en la evaluación
neuropsicológica. Revista Electrónica de Psicología Iztacala, 16(2), 407–417.


Received: March 14, 2016
Accepted: June 05, 2016