Notes for supporting an epistemological neuropsychology: contributions from three perspectives

Apuntes para una fundamentación epistemológica de la neuropsicología: aportes desde tres perspectivas

Review

Mauricio Barrera Valencia[a, *], Liliana Calderón Delgado[b]

[a] *Cognitive psychology research group, Faculty of Social and Human Sciences, Universidad de Antioquia, Medellín, Colombia*

[b] *Psychology, health and society research group, Faculty of Psychology, Universidad CES, Medellín, Colombia*

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ABSTRACT

A review of the epistemological basis of neuropsychology is done in order to clarify its foundations and its dual status as a discipline rooted in biology and psychology. This work is justified from two fundamental issues that are faced by neuropsychology: from an external perspective based on the upswing of certain disciplines, which by definition seem to have similar subjects of study to neuropsychology; however, given the complexity of the study of the relationship between the behavior and the brain, it leads to a duplicity of efforts that do not add anything to the understanding of the subject matter. On the other hand, from an internal perspective, the main issue appears when diverse theoretical positions are presented within neuropsychology as schools that must stand as if they were the only perspective. To provide a tentative answer, this paper reviews three theoretical approaches within neuropsychology: Russian reflexology and the cultural-historical perspective, connectionism, and cognitive neuropsychology. The conclusion leads towards a set of principles that, as a proposal, should guide the discipline development.

Key Words:
Neuropsychology, Epistemology, Neuroscience, Cognitive Sciences, Connectionism, Cognitive Neuropsychology

RESUMEN

Se hace una revisión de algunos elementos que permitan indagar por las bases epistemológicas de la neuropsicología con el fin de contribuir a clarificar sus fundamentos y su doble condición como disciplina anclada en la biología y la psicología. Se justifica el trabajo a partir de dos problemas fundamentales que enfrenta la neuropsicología: por un lado uno de carácter externo, basado en el auge de disciplinas que por definición parecieran tener objetos de estudio muy similares a la neuropsicología y que si bien, es loable este esfuerzo, dada la complejidad del estudio de las relaciones entre el comportamiento y el cerebro, conlleva una duplicidad de esfuerzos que no aportan a la comprensión del objeto de estudio; y por el otro, existe un problema interno al presentarse diversas posturas teóricas dentro de la neuropsicología a manera de escuelas que tienen a erigirse como si fuesen la única perspectiva. Para ofrecer una tentativa de respuesta, se revisa de manera resumida los aportes de las ciencias cognitivas y la neuropsicología, para posteriormente presentar los supuestos teóricos de tres aproximaciones dentro de la neuropsicología: la reflexología rusa y la perspectiva histórico cultural, el conexionismo y la neuropsicología cognitiva. Se concluye con una serie de principios que a manera de propuesta pudieran guiar el desarrollo de la disciplina.

Palabras Clave:
Neuropsicología, Epistemología, Neurociencias, Ciencias Cognitivas, Conexionismo, Neuropsicología Cognitiva

* **Corresponding author:** *Mauricio Barrera Valencia, Facultad de Ciencias Sociales y Humanas, Universidad de Antioquia, Calle 67 Número 53 - 108, Medellín, Antioquia, Bloque 9 oficina 404, E mail: csmaobarrera@antares.udea.edu.co*

1. INTRODUCTION

Neuropsychology is a discipline where a detailed understanding of how a complex structure is organized itself (the brain) with a detailed analysis of the individual behavior in order to establish their neuroanatomical correlates converges (Arnedo, Bembridge, & Triviño, 2013; Junque & Barroso, 2009). It is clearly a difficult task, since it involves a huge conceptual leap attempting to integrate molecular and functional aspects of the brain (micro level) with diverse ways of human behavior (attention, memory, language, emotion, among others) (macro level) (Kandel, 2007; Popper & Eccles, 1993).

That is something dangerous given the current spate of new knowledge and sophisticated techniques that seem to be marking the final victory of Spinoza's materialism, to the point that it seems licit to use molecular biology and neurophysiology to explain shamelessly the complex ways of human behavior (Damasio, 2005). There are several voices that warn about the danger of scientific reductionism, in which Occan's razor ends up selecting simplistic explanations that little contribute to real human understanding. As if this were not enough, there are several factors that influence this relationship requiring the practitioner to stop at his study in order to have a complete view of the brain-behavior relationship. Between these factors we find the environment (mainly the social one), learning, developmental stage and emotional and motivational states, to name a few (Kolb & Whishaw, 2008).

Despite its contribution has been crucial in the set of progress made by the neurosciences, their conceptual and methodological boundaries present two problems according to authors' opinion: an external issue and an internal issue. The external one is evident when comparing its study object with other related disciplines such as behavioral neuroscience that arises from the interaction between physiology, anatomy and psychology (Cooper & Shallice, 2010); or cognitive neuroscience in which study object is to know how cognitive and emotional functions are implemented in the brain (Enriquez, 2007). Although in the beginning it is a healthy effort since, as Benedet (2003) states, the complexity of the study object requires joint efforts from some disciplines, real contributions and neuropsychology development will be only possible to the extent to clarify its role in the neurosciences and cognitive sciences group. To achieve this purpose, it is necessary to have a solid epistemological ground that allows going beyond to obtain empirical data.

The internal problem refers to various approaches that have emerged within the same neuropsychology, in such a way that today we speak of cognitive neuropsychology (Cooper & Shallice, 2010), an historical and cultural neuropsychology (Quintanar, 2009), a connectionist neuropsychology (Geschwind, 1965), or a neo-connectionist neuropsychology (Plunkett, 2001). This situation is due largely to a fundamental problem of neuropsychology related to the delimitation of what is exactly what can be located in the brain: Are they functional systems, cognitive processes, or modules and distributed networks characters?, which will be discussed in detail below.

An additional aspect is related to basic elements of the whole epistemology. In respect to neuropsychology, the subject that knows, the study object and the concept of real tend to converge in only one aspect. A consequence of this situation is tackled in the philosophy of mind through three classical problems about the way humans know their world (i.e, the most etymological variant of epistemology): The first one is focused on the relation between the physical and mental dimensions, i.e. the mind-body problem (Damasio, 2005, 2010; Martínez-Freire, 2007; Ramachandran, 2012); the second one is associated with the source that produce mental contents, i.e. ¿contents are typical of the mind (being the innatism the most current version) or are they acquired through experience? (empiricism) (Jacobson, 1995); and the third one is a problem known as perspectives of first and third person (Churchland, 2002; Gomila, 2003), which makes reference to the inherent difficulty to know the contents of mind in other people that are different from the mind of an individual in first person (Wilson, 2002). Answers of these questions influence decisively the understanding way of neuropsychology, and they need a reflection separately beyond the limits of this text. Thus, the objectives of this review will be *enquiring about some epistemology aspects that support the scientific tasks in neuropsychology from three theoretical models*

To achieve this purpose, we will begin with a basic definition in which neuropsychology is a discipline that studies the relationship between brain function and behavior (Lezak, Howieson & Loring, 2004). As its name implies, it is located at an intermediate point between psychology and neurology or neuroscience (recent use), transform it into a "no man's land that is for everybody for the same reason" (Eslava-Cobo, 2009, p. 9).

According to Kolb & Whishaw (2008), the term neuropsychology was first used in 1913 by William Osler. However, its use was only popularized through Hebb's work in 1949 entitled: "The organization of behavior: A neuropsychological theory".

His classical work method has been about brain injuries and their relationship to behavioral alterations in an effort to associate such changes with its anatomical substrate. In a time in which neuroimaging did not exist, the neuropsychological methods constituted an obligatory reference for establishing neuroanatomical correlates from clinical patient (Lezak et al., 2004; Marshall & Gurd, 2010). It developed standardized instruments objectifying the observations made and several of its representatives proposed systematic procedures to select patients with similar lesions in order to validate their observations in a wider range of the population (Rains, 2004; Heilman & Valestein, 2003).

Currently, with the development of non-invasive techniques for brain study, its role has been changing because it is no longer about identifying the anatomical substrate from the clinic, but to establish what are the alterations that result once it has been identified the precise site of injury. The aforementioned is in accordance with the view of the wide topographic variability presented in the brain functions.

However, despite their undeniable contributions to the understanding of this relationship, some conceptual gaps arise and end up taking an eclectic position, probably based on pragmatism when it is investigate the model of brain function that underlies their scientific task.

Thus, the brain is described from modules, changes are explained in terms of disconnections between functional centers, the work is done from dissociation methods and syndromic analysis functions, rehabilitation strategies are proposed from a sociocultural perspective, and statistical techniques are used to tackle the functioning in factorial terms, among others. From the methodological point of view, assessment tools are made from experimental and cognitive psychology works, and psychometric methods are employed to validate their use in specific population groups.

Although this procedure has been partly justified by the very complexity of the brain, neuropsychology can only advance as a discipline to the extent that satisfactory solves a central problem related with the way psychological functions are organized in the brain. To do it, Luria (1979, 1983) argued that three related problems must be answered:

- What is a psychological function as a psychological phenomenon?
- What is the brain as a substrate of psychological functions, i.e. what are the principles of its organization?
- How, precisely, psychological functions correlate with brain structures, i.e. what is locatable and what has to be understood as brain mechanisms of psychological functions?

It should be pointed that despite the advances in neuroscience in relation to the understanding of brain function, these are questions that continue in full applicability because the current state of neuroscience in general and neuropsychology in particular is largely pre-theoretical: it is full with a great quantity of data, but it has a lacking of efforts to theorize and pose hypotheses from that information (Churchland & Llinás, 2006). Actually, the question about what is exactly locatable in the brain, Llinás himself maintains that is not justifiable that neurons or specific areas were responsible of faces processing or psychological functions, as memory, in an isolated way (Llinás & Paré, 2006).

With the purpose to provide concisely a general view that provides a little of clarity about it, this text will have two parts: the first one is orientated to present succinctly some conceptual basic elements of cognitive sciences and cognitive neurosciences. In the second one, they have been selected three perspectives of neuropsychology about the brain functioning that can contribute to the following: on one way to the proposal from the Russian reflexology and the cultural-historical perspective represented by Pavlov, Vigotsky and Luria; on the other hand to the connectionist proposal in its two perspectives: the one derived from Wernike's models and the subsequent development from Geschwind's works and the perspective originated from the processing models distributed in parallel. Finally, the cognitive perspective is taken, which is probably the one with higher boom in current neuropsychology.

2. COGNITIVE SCIENCES AND COGNITIVE NEUROSCIENCES

2.1. Cognitive sciences

According to Thagard (2005), cognitive sciences are a set of disciplines that aim to study mind. He points philosophy of mind, cognitive psychology, artificial intelligence, neuroscience, linguistics, and anthropology as integral disciplines. In addition, it was originated in the decade of 1950. Although he does not specify exactly to what it makes reference in respect to "mind", he emphasizes in the interest of cognitive sciences to clarify the way in which thinking works are carried out, indicating with this the operations that mind carry out to solve problems, learn, and think. Finally, he maintains that the main hypothesis of cognitive sciences is "understanding mind in terms of structures of mental representations in which computational processes work" (p.28), but he clarifies that there is not an agreement in respect to representations nature and computational processes that constitute thinking.

On the other hand, Gardner (1987) considers that the theoretical bases of cognitive science came from mathematics and logic based on the syllogistic reasoning that involves the manipulations of abstract symbols. This proposal, which was initially formulated by Frege, was originated in a parallel way with the appearance of the first modern computers and they were the base of the new science of mind and the artificial intelligence. A fundamental contribution was the work of Turing, (1950), who formulated the idea of a simple machine known currently as the universal Turing machine. Among its uses, Turing contemplated the possibility that it could simulate the human cognition because of the following assumptions (Michie, 2002):

- Programming can be made in symbolic logic, which would require the creation of suitable translator/interpreter programs.
- Automatic learning is needed to allow computer producing new discoveries in both the inductive and deductive ways.
- It is required to prepare suitable interfaces for humans in order to allow machines adaptations to people and thus, they can acquire knowledge in a tutorial way.

In 1956, the Symposium about Theory of Information was carried out in the Massachusetts Institute of Technology (MIT), where cognitive science was formalized since the idea that all the processing systems follow the same principles (biological systems as the humans one or metal and silicon as the computational ones) and that its matter is constituted by an unified study field: cognitive science (Newell & Simon, 1972). Thus, the main issue of cognitivism is the representationalism, which presents that the only way to tackle intelligence consists in working over representation bases that acquire physical reality with the form of a symbolic code in the brain or a machine (Varela, Thompson, & Rosch, 1992).

Rabossi (1995) argues that cognitive sciences can be summarized using a minimal theoretical matrix about the following assumptions:

1. Human beings and, in general, all devices to which can be attributed cognitive states and processes are processing systems of information.
2. Information processing involves rules, symbolic elements with syntactic traits (formal), and computational operations (algorithmic) about these items.
3. Cognitive processes involve information processing.
4. The symbolic elements have a representational character; inner representations have a descriptive nature (propositional).
5. The cognitive mechanism study demands an abstract level of analysis, i.e. a level that allows specifying the method used by the organism or device to carry out the informational function.
6. This abstract level is the computational one (software); all cognitive processes are computational processes.
7. All cognitive processes are implemented in a physical base (hardware), but the computational specification sub-determines the physical level of implementation since different physical bases can implement a same program type.

Nevertheless, cognitive science faces several conceptual problems derived in large part from its own inner structure as theoretical model despite its incredible advances. Two of those difficulties are particularly interesting for neuropsychology: One of them is related to the real possibility of simulating a mental state in a non-human device. The argument known as the Chinese room is a mental experiment where a person that just can speak English gets inside a room full of Chinese characters. Outside the room there is a group of people that send instructions in Chinese in form of questions. He/she does not know that those are questions but has a book of instructions in English that allows sending the right Chinese symbol. Observers outside the room could think that this person speaks Chinese although it is not true (Searle, 2002, 2006). In a similar way, we could apply the Touring´s test to a machine or a brain different from the ours (problem of first and third person stated in the introduction) and think that it has intelligence, when actually it is a program that have instructions to solve the questions without requiring a real understanding of the type of questions that were posed.

The second problem of cognitive sciences is related to the theory of information developed by Shannon in the forties and that today predominate in largely part of the computational development. The problem, as it is stated by Denning and Bell (2013), is that information processing is carried out in a different way from the meaning one, which constitutes a contradiction since it is the meaning that produces a modification in the receptor. The critic is relevant for neuropsychology because if brain is studied as an information processor, the question of the moment lies in that it gives meaning (or if there is actually a meaning attribution).

2.2. Cognitive neuroscience

Kandel (2007) defines the neuroscience in general as a set of disciplines that has as objective unraveling the biological bases of mind. Whereas, Albright and Neville (2002) define cognitive neuroscience, in particular, as a discipline that studies the information processing from a biological perspective. This field tackles from classical questions as the way in which information is acquired (gnosia), the way in which that perception is integrated to produce movements patterns (praxia) including processes that regulate learning and memory, and enquire about biological mechanisms that allow the executive functions, the social cognitions, and consciousness. To tackle such problems, several tools are used such as the single neuron electrophysiology, structural and functional brain imaging, genetic manipulation, neuropsychology and neural computing, among others.

From a historical perspective, the development of neuroscience has been characterized by opposite positions about a set of fundamental subjects that have constituted in largely part its purpose and uses. Thus, in the dawn of the scientific study of the brain (in the middle of XIX century), discussions revolved around the locationalist postures (in which psychological functions were possibly associated with specific areas of the brain) vs holistic postures (in which psychological functions required the whole brain structure to carry out such functions). In favor of the first ones, there were the works of the pioneers Broca and Wernike, and the explanatory attempts of phrenology. On the other hand, there were the works of Fluorens and his cerebral ablation techniques (Kolb & Whishaw, 2008). By the late nineteenth century, the discussion was focused on the structure and function of the elementary units of the nervous system giving place to the reticulum theory (according to which brain tissue was composed of a large indivisible reticulum) vs. the neuron theory that on the contrary argued that the nervous system, as well as other bodily systems, was made of discrete units called neurons (Finger, 1994). With the advent of modern techniques for staining and microscopy, it has been possible to detail the neuron structure and function. Also, the old argument about the functions location seems to be solved with connectionism in its different aspects, but with the advent of neuroimaging studies, it seems to go backwards to a kind of localizationism (Bennett, 2008), typical of a modern phrenology.

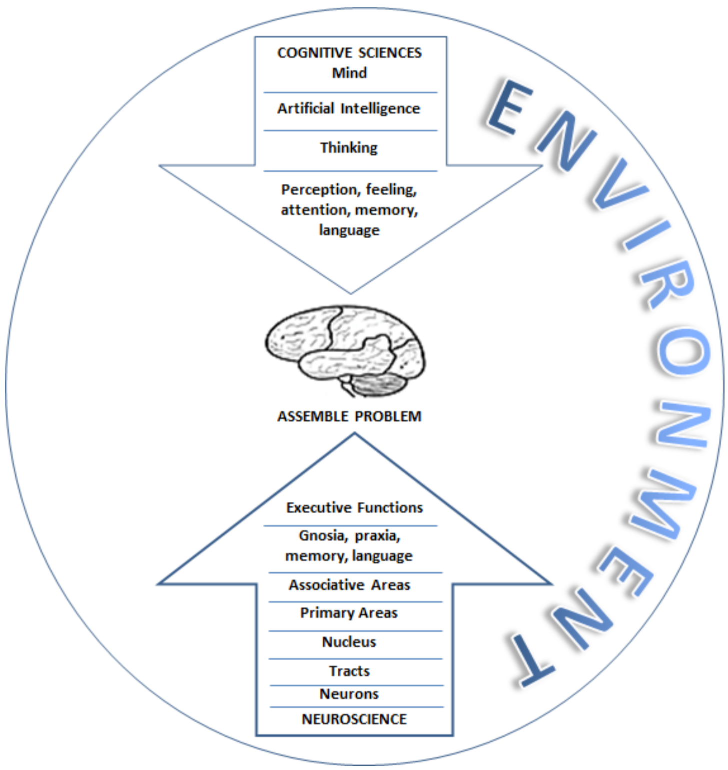
Much of the work in neuroscience has been aimed at understanding the details of the circuitry that integrates the brain tissue hoping to one day explain the psychological functions through neurons, synapses, and neural and tracts networks. From Broadmann's to Kandel's work, there are contributions with a very complete view of brain structure (Purves et al., 2010). Under the surface, the brain architecture is a massive interconnection of wires axons, which are configured according to predetermined patterns. However, despite this intricate interconnection not all neurons are connected with each other, but they make networks that allow sending information forward, inhibiting it or returning it. Learning will determine which of these processes happens since it strengthens or weakens those connections (Damasio, 2010).

With regard to the cerebral cortex, it is understood that much of the structure has a modular and columnar organization, in which the information processing occurs hierarchically and in parallel, giving place to an informational processing called "Bottom-up/top-down" (Maldonado, 2008). From the evolutionary point of view, there has been produced a corticalization of the functions. In that way, functions that in older evolutionarily species were coordinated by nucleus are now assumed by specific areas in the cortex (as in the case of the colliculus, which in reptiles plays a role in vision and hearing, while in humans, despite it is still present, its functions have been taken in largely part by the occipital and temporal cortex respectively, leaving more basic aspects to the colliculus control, such as the orienting reflex. In addition, it is possible to distinguish primary and associate areas, among many other advances in the way it is organized (Papini, 2009).

However, as in the cognitive sciences, there is a number of criticisms regarding its procedure and data analysis way. Specifically, the questions about Cartesian explanations are relevant to neuropsychology, where it is intended to replace the body by the brain, attributing it mental properties (Dennett, 1995). Another aspect is what Bennett and Hacker (2008) call the mereological fallacy, in which it is a mistake to attribute functions to a body that actually correspond to the entire organism as a whole. In authors' words: "*The attribution of psychological characteristics to the brain is not endorsed by any neuroscientific discovery to show that, contrary to our previous beliefs, the brain actually thinks and reasons, as we do ourselves*" (p 35).

As shown in this summary presentation of cognitive science and neuroscience, their work perspectives are different though its subject matter is very similar. In a simplified way, this relationship can be visualized in Figure 1, in which we can see that the neurosciences are based on the detailed study of the basic units of the nervous system, to then integrate this knowledge to the understanding of more elaborated ways of information processing. On the other hand, there are cognitive sciences based on a global understanding of information processing to try to establish how it is integrated with the most basic forms of that processing. The big problem that faces both disciplines is related to the way in which the different components are assembled and that is still today far from being satisfactorily solved.

Figure 1: *Schematic relationship of cognitive science and neuroscience. Consult the text for an explanation.*



With this background, it will then describe three different perspectives that have contributed decisively to the process of neuropsychology consolidation.

3. THE RUSSIAN REFLEXOLOGY AND CULTURAL-HISTORICAL PERSPECTIVE OF VYGOTSKY

It is probably that some readers consider very little appropriate to place in the same section the theoretical and methodological proposals of Ivan Pavlov, Lev Semenovich Vygotsky and Alexander Luria. However, when reviewing their writings, each one (except Pavlov) has felt stimulated by the ideas of their fellow-countrymen either affirming or rejecting their theoretical proposals. For example, both Vygotsky and Luria, agreed that Pavlovian reflexes could explain the basic forms of brain functioning, but disagreed with the explanation of the complex forms of behavior from such mechanisms (Glozman, 2007). Nevertheless, their contributions together are largely the result of a time full of contradictions, but also fruitful from a scientific point of view.

In this way and according to Luria the conception of brain as part of mental activity developed principally, after meeting Vygotsky in 1924 with Leontiev, a psychological approach that trained them to describe the way in which the natural processes such as physical maturation and sensory mechanism converge with processes determined culturally to produce psychological functions of adults (Cole, 2002).

Luria agreed with Pavlov's criticisms in relation to localizationist and anti-localizationist positions of the brain and suggested that the common problem to these positions is related to the way we understand the concept of psychological function as an indivisible unit and to trying to explain brain functioning from these global psychological functions (Luria, 1983).

For this reason, Luria redefined the superior psychological function concept and its relation to the brain in this way:

> *"....the superior psychological function (i.e. the one that arises during life, and that is mediated and regulated voluntarily) is not a unitary psychological phenomenon that cannot be divided into constitutive parts, but the complex form of psychological activity that is incorporated in its structure for guiding motives, goals (program), business links (actions and operations that are included in them) and control mechanisms "*(Luria, 1972, p. 15).

Pavlov, meanwhile, considered that it was a physiologist necessity to unravel the mechanism that gave place to the functioning of those structures, opposite to psychology, with a scientific methodology based on physics, chemistry, and biology. Since he wanted to establish the laws that regulated the functioning of the brain hemispheres, he adopted the Sechenov's posture, which described the hemispheres activity from reflex activity (Pavlov, 1997). In this manner, he assumed a deterministic posture to explain behavior; he developed the conditioned reflexes concept that tackles two basic processes: excitation and inhibition. Excitation was a positive process whereas inhibition was the opposite force that paralyzed the function. Thus, the main contribution to neuropsychology is focused on explaining the complex forms of behavior from a set of stimuli that triggers responses (conditioned or unconditioned) regulated by excitation or inhibition processes that activate or paralyze the organism response.

In addition to being critical about the localizationist and anti-localizationist positions, he suggested that the function is the result of a complex reflex activity that group the common work of an assortment of inhibited and excited areas of the nervous system, which allow the creation of a system of temporary connections and ensure the balance of the organism with the environment through analysis processes and signal synthesis (Pavlov, 1997).

Vygotsky, by contrast, was interested in scientifically explain psychological processes from a cultural-historical perspective, considering that the development of superior mental processes had a social nature. His studies were particularly focused on language and movement, and it was from this search that he made a number of principles that later inspired Luria to develop with Vygotsky a non reflexological psychology that was framed in the study of evolutionary development. This proposal would include the socially meaningful activity, and how to solve the problem of the relationship between superior mental functions and lower elementary mental functions (Kozulin, 1995).

Regarding brain activity, some of the principles of Vygotsky's theory were related to the postures about the function of the general and the partial elements, pointing it out as a product of integral activity of strictly differentiated centers and related hierarchically among them. Similarly, he makes the difference between the function of the brain as a whole (background), and the function of a part (figure), explaining that "the background in brain activity is represented by the lower psychological functions and the figure is represented by the superior mental functions, and vice versa" (Vygotsky, 1982, cited by Akhutina, 2002).

Thus, following Vygotsky's thoughts

> "*the specifically human functions that are acquired in social experience during training process change the functional structure and, simultaneously, its reliance on innate biological mechanism: if functions are determined by biological mechanisms in the beginning, the biological mechanism would be determined by the functions later*" (Vygotsky, 1995 p. 42).

It is based on these general approaches, and returning to Luria, that neuropsychological assessment should be based on a (structural) qualitative analysis of the symptoms under study, and specify the defects observed and the causal factors associated (Luria, 1969 cited by Glozman, 2007).

In this way, he proposes to carry out the injuries analysis based on a principle coined by Teuber as "double dissociation". According to this principle, "a local brain injury that affects all of the functional system is not only typically reflected in a unique psychological function. As a rule, a group of psychological processes will break up while others will remain intact" (Luria, 1972 p. 18)

Finally, Xomskaya (2002) affirms, in relation to the neuropsychological system proposed by Luria, that this system differs from the "Western" tradition in two fundamental aspects: the first one is associated with the psychological origin opposite from the medical origin that was acquired by western neuropsychology; in the second one, the interest was in qualitative analysis of the alterations opposite to western neuropsychology that had special interest for the quantifications through the use of statistical and psychometric methods.

It should be mentioned that some authors consider there are a huge similarity between Luria's works and connectionist models (see León Carrión, 2002 for instance). However, from a historical perspective, the basis in which Luria' postulates emerged were based, principally, on the study of the brain in normal and lesion conditions. Whereas, connectionist appears to try to model brain from modest structures that are connected for the brain information processing. Although these are different ways that sometimes lead to similar conclusions, to deal with them separately could help to better understand the contributions of each one.

4. CONNECTIONISM

In the connectionist model, it is possible to identify two aspects: the first one appears from Broca and Wernike's works, which allow, in the middle of XIX century, a way to analyze brain lesions based on diagrams in which it was described a set more or less specialized of neurons connected through a set of modest networks that were used to deduce a series of complex symptoms. This procedure allowed a classification, which prevailed until world war I, based on lesions derived from alterations in gray and/or white matters (Catani & Ffytche, 2005). It was a very useful model that made possible that authors such as Dejerine in 1892 described a case of pure alexia without agraphia, or Liedmann in 1907 who analyzed the effects of a callosal disconnection in respect to the motor function (Kolb & Whishaw, 2008).

Geschwind (1965) takes these works and presents a pile of studies that aim at developing explicative models of the principal neurological syndromes from disconnections, especially those of the corticocortical type. That is why he went back to an old principle conceived by Flechsig at the beginning of the XX century, which stated that primary sensorial areas have mielyn at borning whereas association areas (with longer projections) get it during the ontogenetic development. Generalizing this principle, in the motor networks is the new Geschwind's contribution. Nevertheless, it is more interesting that it was considered a second aspect related to the observation about the afferent networks that made a link to the limbic system of animals, whereas in humans and some primates it is presented a higher development of the inferior parietal areas, where integration of associative networks of several sensory types occurred. Based on these elements, Geschwind devised his disconnection syndromes model in the following idea:
"*If associative cortex lesions are enough extensive, they lead to a disconnection of receptive or motor areas of other regions of the cortex, in the same hemisphere as much as the contrary one"* (Geschwind, 1965, pp. 244).

In this theoretical framework he could analyze the gnosia, apraxia and language with a completely new perspective. Subsequently, authors such as Damasio (1989) and Mesulam (1990) enriched the model with aspects related to directions in which information travel; it can move forward, behind or in a parallel way (Damasio, 1989; Mesulam, 1990). Although currently it is not possible to explain the wide range of alterations based only on disconnections, his contribution has been essential for the development of clinical fields such as neurology and neuropsychology.

A second aspect perhaps less developed in neuropsychology came from processing systems by means of the integration networks configuration by units of simple processings that pretend to simulate the neural functioning (McClelland, 2002). At the very beginning, in the eighties, it appeared as an alternative for the models derived from the computational theory of mind. In this approach, mind was considered as a complex organization of systems in interaction, in which each one carry out a specific cognitive function and processes information through quasi- linguistics discrete symbols manipulation (Ramsey, 2002; Tienson, 1995).

According to McClelland (2002), connectionism offers a completely new view of psychology theory nature. Connectionist networks configure cognition through activation spreading of many simple units. Thus, processing is widely distributed in all the system and there are not specific modules for an only task, discrete symbols, or explicit rules that regulate operations. On the other hand, there is a different processing that is defined as parallel distributed processing (PDP), in which a mental representation is constituted by an activation pattern of the units set of the processing model. This processing occurs thanks to the activation spreading among connectionist networks through balanced connections (McClelland, 2002). Nevertheless, it should be noted that connectionist networks constitute very simple representations since they are integrated just by units and connections. In the same way, connections can be unidirectional with an activation that move from a unit to another one in an only way, or they can be symmetric when activation spreading occurs among units in both directions. Besides, connections can have a nature of excitation or inhibition, i.e. the unit can stimulate or suppress the activation of another unit (Thagard, 2005).

As it can be inferred, it is a very interesting model for neuropsychology because, among other things, it can represent complex patterns of behavior through a model that presents a huge similarity with neuronal networks, which are constituted by neuron bodies that allow creation of nucleus (gray matter) and axons that form connections in the white matter.

However, it is not easy to use this model in the clinical practice because of the tools and the analysis levels of neuropsychology. The possibilities to carry out researches are linked to the development of informative models that simulate such networks.

Perhaps the work line more productive in investigation has been orientated to develop informatics models from which are carried out the analysis of certain tasks. Once the model has "learned" the task, it is damaged a determined number of nodes in order to establish the execution effect. It is from this point that neuropsychology analyzes this data and establishes relations with patients who present similar lesions.

In the clinical field (and also the investigative one), evaluation instruments and information analyses levels of patients are based on more than a module perspective in which the brain is constituted by interrelated units that are independent regarding their development. It is a proposal that came from the work of Marr (1978), who warns about the intrinsic difficulties of confusing a computer with a human brain. In his proposal, he maintains that in order to carry out a complex calculation, such operation can fragment a set of relatively independent processes. He suggest also that from an evolutionary perspective, the unit conformation of brain would allow, as in a computer program, carrying out improvements without affecting in a fundamental way the entire system (Marr, 1978).

5. COGNITIVE NEUROPSYCHOLOGY

In the eighties, it was produced a very productive approach between psychology and cognitive science that questioned the neuropsychological work that focuses its final objective on lesions locations through patient alterations descriptions as much as the inclination to establish functioning analysis through the average achievement of a patients' group. According to authors such as Manning (1990; 1992), neuropsychology should go beyond and develop cognitive models that explain alterations in patients to constitute a model and not the lesion in the unit of analysis of the neuropsychologist in a normal or pathological state. His contribution is in accordance with Shallice and Cooper (2011) regarding the possibility of isolating and characterizing the operations of specific subcomponents of the cognitive system by means of the study of specific lesions. It is developed an approach in terms of information processing and the incorporation of a module perspective about the understanding of the brain functioning (Parkin, 2004). Those modules have particular characteristics that Fodor (1995) synthetizes through a set of features such as:

- Informative encapsulating: modules carry out their operations in an isolated way regarding what occurs in other places
- Control specificity: each module processes only one entry type
- Obligatory feature: each module works in an "everything or nothing" mode in such way that once they are activated, they carry out the processing.
- Innatism: cognitive system modules are inmate and are not acquired through development.

Although the latter point has been matter of a wide controversy, in general, it could be affirmed that from this view the conceptual aspects of functions that are normally tackled by the neuropsychologist are devised. Thus, in respect to attention, memory, language, praxia, or gnosia, the analysis normally starts in the breaking down of the more molar aspects of each one of these functions to later provide a function interpretation as an independent module and in relation to the other ones that integrate the cognitive functioning. An additional aspect is constituted by the distinction of what Fodor calls main processes, which are different from the module processing because they would be responsible of integrating the information. Thus, they are not specific in respect to the aspects they analyze and in general do not have the said criteria for module conformation, according to Fodor (1995) they are:

> *Slow, deep, more global than local, widely under voluntary (or executive) control, typically associated with diffused neurological structures, not ascendant or descendant in respect to their processing ways but characterized by calculation in which the information flows in all directions. First of all, they are not paradigmatically encapsulated: the higher it is a cognitive process, the bigger is the number of different domains in which it is based to integrate information"* (pp. 4.).

From this view, there would be two kinds of cognitive systems: The modules that would be calculation organization modes of vertical kind that are encapsulated and specific of modality, and main processes that would be formed of horizontal calculation organization, which are relatively independent of the area and are not encapsulated. This would be the foundation of cognitive neuropsychology according to Benedet (2002) and the model in which is provided a huge quantity of data from current neuropsychology according to authors. However, some of them as Shallice (1991) agree that Fodor's theory requires a review about the basic assumptions and being updated because of the recent developments. In respect to that, Farah (2002) considers that if the assumption about the informational encapsulation is accepted, it implies a specific location of such module in the brain. Nevertheless, lesions effects do not seem to behave as specific areas, but as an alteration continuum throughout a specific circuit.

6. CONCLUSIONS

In conclusion, it could be affirmed that neuropsychology is fed, at less partially, by the approaches of three perspectives discussed in this paper: the one that came from the Russian neuropsychology, the connectionism, and the cognitive neuropsychology.

However, it should be pointed the need of assuming a theoretical posture that allow integrating the advances of a discipline within a solid body of principles that guide the interpretation and research programs to advance in the consolidation of this discipline. It is emphasized that neuropsychology is inherent to a neuronal aspect that supports different cognitive functions and to psychology; although these are processes that appear from a neuronal substrate, they have a set of independent features that can greatly determine the neuronal functional of brain (as what was proposed by Brentano) (Smith, 2002).

It is from this intermediate point that its role is double: In one way, it should warn about the excessive reductionism when pretending to explain all the behavior by means of only biology; and on the other hand, it should avoid excessive mental postures that ignore completely the possibilities of a biological system to determine its plausibility. In the same way, the authors of the present work consider important that such programs of research add a minimal matrix of principles that can rule the neuropsychological tasks. Such principles could consider, among others, the following aspects:

It is clear that the brain works in terms of excitatory and inhibitory patterns in both molecular level and in the performance of the most superior functions. For that reason, any theory should start from this fact as a cornerstone of work in neuropsychology.

The information processing is performed vertically, in terms of bottom-up and top-down mechanisms, the former being less sensitive to learning compared to top-down processes, where previous experiences facilitate or hinder the process of the input information. As it was aforementioned, this aspect is a key to neuropsychology whenever the bottom up processing corresponds to neuronal functioning, whereas the top-down processing is related to the psychological aspects of the individual.

It is necessary to note that apparently there is no exact correspondence between the observed world and the interpretation that the brain makes from that observation; it is probably due to the processing of top-down type.

It is not possible to understand brain functioning without taking into account the deep interaction between it and culture, and that such interaction is probably made in a dialectical way, in such a way that the brain evolves to the extent that culture is more complex and this, in turn, evolves thanks to the increased complexity of brain structure.

It is also proposed to assume a perspective of evolutionary nature of brain functioning from both phylogenetically and ontogenetically view.

Regarding the way the already said functioning is given, it is suggested to assume a Luria perspective, according to which a brain function is structured from sub-processes that may be involved in different functions while keeping some specific tasks.

From this perspective, the neuropsychology objective would consist in identifying the sub-processes that could be affecting transversely the different superior psychological functions, or as Luria would say (1983), neuropsychological factors.

Finally, the learning variable determines largely the performance and brain organization due to its plasticity. Thus, the activities that are over learned assume a different brain fixation pattern, which seems to be from the front structures to posterior areas and/or from the cortex to the subcortical structures (e.g., reading and motor learning).

There is a similar pattern of operation of each of the areas that constitute the brain, but how they are interconnected and related to fulfill a specific task varies from individual to individual and this differentiation is given by the ontogenetic development, and experiences and learning they have acquired.

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