A Study of Cerebral Processing Asimmetry Based On Neuropathology Data

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Abstract

The article underlines the practical importance of evaluating the approach of the functional and structural cerebral asymmetry form a neurophysiologic and anantomopathnological perspective.

The experimental demonstration of the fact that the cereberal hemispheres constitute two distinct structural and functional systems has opened new expectations in the psychology of personality. The research initiated and carried out by Roger Sperry and his coworkers brought convincing proof that the two cerebral hemispheres clearly differ from each other in point of content and ways of information processing. The analysis of the contemporary neuropsychology data has imposed the idea of a direct correspondence between the dynamic-structural organization of personality. These types of relations offer an objective basis for the unerstanding of the informational nature of the human psychic system and to explain the anticipative mechanisms of the human behavior.

Key concepts: *"hemispherical dominance", "cerebral functional asymmetry", "lateral prevalence", "lateralization process", "neurological and functional laterality", "interhemispheric functional specialization", "amnesic aphasia", "agraphia", "alexia".*

1. The issue

The concept of functional and structural interhemispheric asymmetry was developed with difficulty and rather late in psychophysiology, alongside the understanding of the way the brain works and is organized, in order to explain the human and animal behavior. The phenomenon of the cerebral neurofunctional specialization has been noted in neurology on several occasions and recorded in different papers and studies that have been published over the last one hundred years.

Most of this research tried to find solutions as substantiated as possible from an experimental and epistemological point of view to the following essential problem that was starting to arise on the horizon: is it possible that two anatomical structures- in this special case the cerebral hemispheres, symmetrical from a morphological point of view, should develop different functions?

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2. The neuropsychology of the functional cerebral asymmetry as an explanatory basis of the internal psychic organization of the personality and behavioral style

The discoveries made in the clinical neurology almost one hundred years ago have led to the formulation of the conclusion according to which the cortical lesions in the left cerebral hemisphere trigger dysfunctions in understanding language and in some cases even the impossibility of everyday verbalizations.

The recent data, offered by the possibility of cutting off the superior connections between the two cerebral hemispheres through the sectioning operation of the callous body, have led to the formulation of the troubling hypothesis of the existence of two separate centers of the conscience "in a single cranium" (J.E. Bogen 1969, R.W. Sperry 1986). Moreover, the perfecting of psychological testing techniques of the callostomized and comisuro patients has pointed out an obvious functional specialization of the cerebral hemispheres.

The personality, as a superordered system implies a reciprocal interaction of the behavior with its biological basis, on one hand, and with its integrative social macrosystem, on the other hand. For this reason, the features of personality and especially the behavioral style, as a way of relational manifestation, reflect the multiple conditions imposed on a person, during the process of ontogenetic development. Man assimilates not only the necessary elements from a biological point of view, but also the information that represents the content of processes, states and particular psychic conditions. *"It is this very usual way of being in the world that the psychologist is supposed to know intuitively"*, shows ***R.*** *Mucchielli,* (2000, p. 104), adding: *"we cannot know an individual just by piling up his traits, through a collection of signs that he represents, but we also need to find the principle that after all gives sense to all of these signs**,** the simple movement which characterizes a specific individual, the vivid relationship between a conscious organism and its environment"*(ibid). As it concerns us, we consider that this principle that can offer a more thorough understanding of the structure and dynamics of the evolution of personality, is the principle of interhemispheric functional dominance, based on which we have analyzed and interpreted the data collected in the present research.

Taking into account the fact that each cerebral hemisphere integrates a priority special type of processing of received data, this fact generates the importance of the relations of interhemispheric dominance over the configuration of the mental structure of the specific person and implicitly, over the behavioral manifestations. In this respect, the way of processing the data is characteristic for a subject, as it is defining for his cognitive style, and in a larger context, for his life style.

This new perspective on understanding the ways of processing of psychic data offers a more coherent image for the explanation of the internal psychic organization of personality, but also of the behavioral style and even of the human nature in general.

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Further on, we are going to analyze the neuropsychological essential aspects which are the basis of psychic data processing, with their decisive role in the realization of the internal psychic organization of the personality and behavioral style.

3. The functional cerebral asymmetry from a neurophysiologic and anatomopathological perspective

The neurophysiology studies had initially in view the fact that the two cerebral hemispheres had a symmetrical anatomical structure and, consequently, they developed equivalent functions. But this interpretation has improved a lot since the discovery, in the last century, by P. Broca of the speech centre.

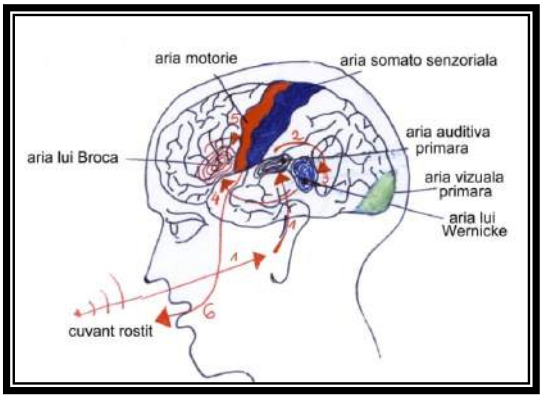


Fig. no. 1 ***The model for the creation and understanding of language.***

When a word is uttered, the nervous impulses in the internal ear are sent towards the primary auditory area. The word can be understood if the signal is sent towards Wernicke's area. In this area the acoustic code of the word is found and transmitted towards Broca's area. This is where an articulating code for the respective word is activated and which it sends directly towards the motor area. The latter coordinates the lips, tongue and larynx for the oral emission of the word (according to C. Arseni, M. Golu, L. Dănăilă, 1983).

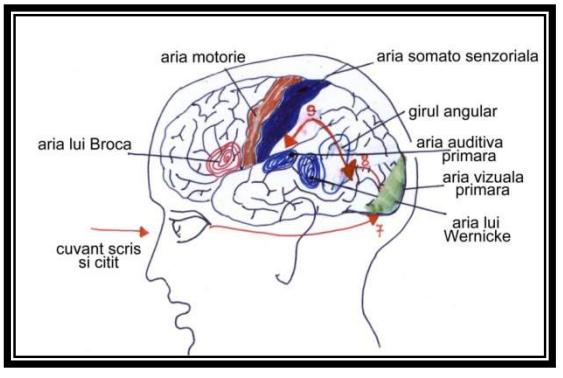


Fig. no. 2 ***The model of the coordination of writing and reading.***

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The visual input of a written word is transmitted towards the visual primary area of the cortex and then it is found again in the angular gyrus. The angular gyrus associates the visual shape of the word with its acoustic code in Wernicke's area. When the acoustic code is found again and the meaning of the word is established as well, the emission of the oral pronunciation of the word is made possible, according to the presented sequences in *Fig. no. 1* (according to C. Arseni, M. Golu, L. Dănăilă, 1983).

In 1861, Broca presented the case of a patient who had lost the possibility of articulated expression because of a lesion in the third left frontal circumvolution. He launched the hypothesis of a global hemispherical dominance and took in consideration the link of this dominance with the motor conducts. Grounding his arguments on his studies on aphasia and, especially, on the discovery of the verbal articulation center, Broca believed that the left-handed person "spoke" with the right brain. Broca's interpretation seems to be outdated today because it postulates a rigid relation between the hemispherical dominance and motility. M. P. Bryden (1986) believed that it was enough to know the left-handed or right-handed person's behavior to draw a conclusion on the cerebral dominance.

Although not substantiated by certain neurophysiology data, these points of view determined a series of research on cerebral functional mechanisms, contributing to the formulation of some concepts as "hemispherical dominance", "cerebral functional asymmetry", "lateral prevalence", "lateralization process", "neurological and functional laterality", "interhemispheric functional specialization" etc.

The approach of the functional and structural asymmetry issue from a neurophysiologic perspective, aimed in the beginning at analyzing the hemispheric dominance phenomenon, which led to the formulation of the idea of partial hemispheric specialization. Later on, the chirurgical and anatomic approach of the cerebral functions was extended to the study of the relations between this type of dominance and manual preference.

With regard to the cerebral hemispheric dominance, it was pointed out by a series of anatomo-clinical and neuro-chirurgical studies, of which the most important are those conducted by R. Brain (1945), A. Paterson and O. L. Zangwill (1944), J. de Ajuriaguerra, H. Hecaen (1963), B. Schlesinger (1951), A. Jeves (1986), R. W. Sperry (1953, 1969), R.E. Meyers (1955), M. Gazzaniga (1970), J. Levi (1969), M. Lassonde (1994), M.I. Botez (1996), L. Dănăilă and M. Golu (2006).

The disorders of the spatial thinking, the unilateral agnosia and the directional and vestibular disorders appear with higher frequency at the right-handed person, as a result of the hemisphere lesions, while at the left-handed person they distribute more equally on the two.

In this respect, J. de Ajuriaguerra, H. Hecaen and R. Angelergues (1960) have stated that the left hemisphere dominance manifests preponderantly for language, while the motor and sensorial amusia can depend on lesions in both hemispheres. Analyzing 415 cases of retrorolandic lesions, the same authors

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have arrived at the conclusion that the ideomotor apraxia is determined by lesions in the left hemisphere in 18.93% of cases and by bilateral lesions in proportion of 15.54%. With regard to the ideatory apraxia, it is caused by lesions in the left hemisphere in proportion of 4.36% and in proportion of 3.81% by lesions in the right hemisphere (J. de Ajuriaguerra, H. Hecaen, R. Angelergues, 1960, p. 32). In the same study, the mentioned authors consider that the dressing apraxia is caused in 21.96% of cases by right lesions, 3.9% by left lesions and 20% of cases by bilateral lesions (idem, p.45).

All neurophysiologic studies point out the fact that object agnosia and color agnosia are the consequence of some lesions in the left hemisphere, while the physiognomy agnosia corresponds to the right hemisphere lesions (J.Sergent, 1996). The spatial agnosia, the disorders caused by having used topographic notions, as well as the loss of the topographic memory must be connected with lesions in the right hemisphere. If acalculias are subsequent to the lesions in one cerebral hemisphere or the other, the alexia of figures depends, mainly, on the left side lesions.

The anatomo-clinical study conducted by J. de Ajuriguerra and H. Hecaen (1963) on a number of 415 subjects which presented temporo-parieto-occipital lesions, pointed out the fact that 16.88% of them presented metamorphopsias as a consequence of some lesions in the right hemisphere, 8.25% as a result of lesions in the left hemisphere, while 3.63% of the subjects had bilateral lesions.

The series of researches based on data in the neuropathology field or supplied by the electroencephalographic method point out that the cerebral dominance must not be rendered absolute.

The studies carried in this field started from left-handed and right-handed subjects with unilateral cortical lesions.

The understanding disorders emerge because of the left hemisphere lesions in left-handed persons, being less frequent in right-handed persons with lesions also in the left hemisphere.

The amnesic aphasias, agraphia and alexia are more frequent in case of left cerebral hemisphere lesions, as it results from the data centralized in the table below (J. de Ajuriaguerra and H. Hecaen, 1963, p. 102): 1963, p. 102):

	Cerebral hemisphere lesions (in %)			
	left		right	
	Left-handed subjects	Right-handed subjects	Left-handed subjects	Right-handed subjects
Amnesic aphasia	13.63	0	54.32	49.69
Agraphia	23.8	15.7	43.24	48.14
Alexia	4.54	0	56.75	50.58

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Acalculias appear almost as frequently in left-handed persons as in right-handed persons, when the left hemisphere is injured. This category of complex cognitive disorders (spatiality, conceptualization, expression etc.) is determined by numerous factors with different capacities in different cases. The conclusion drawn by K. Conrad (1949), M.E. Humprey and O. L. Zangwill (1952) is that acalculias differ from the other language disorders, and in left-handed persons the cerebral dominance is less rigid than in right-handed persons. Most of the researchers agree with the fact that it cannot be established a biunivocal between the preferential manuality and the hemispheric dominance for the language disorders (J. de Ajuriaguerra and H. Hecaen, 1963, p. 171).

Also, praxis disorders do not allow for the emergence of big differences in the injured lateralization in left-handed or right-handed subjects. In ideatory apraxia cases, the respective disorders are situated at the level of the left hemisphere in proportion of 13.5% in left-handed persons and 21.38% in right-handed persons.

The constructive apraxia is much better observed following the right hemisphere lesions in left-handed persons. On the contrary, in the majority of right-handed subjects, it is produced following the right hemisphere lesions.

The object agnosia is more frequent following the left hemisphere lesion in left-handed persons (21.82%) in comparison with right-handed persons (6.35%).

Keeping a functional balance between the cortical areas of the two cerebral hemispheres is done through the functions of the callous body.

The scheme presents different parts of the callous body and their cortical projections (M.S. Gazzaniga, J.E. Le Doux, 1979).

The tumors, degenerative diseases and partial lesions in the callous body, which have been described even from the very beginning of the 20th century, trigger a disharmonic behavior, lack of consistency between ideas, different psychic and personality disorders.

Of the tumors of the callous body, the gliomas present a symptomatology which manifests itself even in the first days of the developing tumor in the shape of epileptic crises and some psychological changes such as disinhibitions, impulsivity, spatial orientation difficulties, memory disorders or apathy. These manifestations cannot be considered as being similar to those characteristic to the callous disconnection syndrome, they can be attributed to the fact that gliomas proliferate in the neighboring cerebral regions, thus causing different touch signs, depending on the affected region .

Another series of psychic disorders is caused by another type of lesion in the callous body, and that is, the progressive demyelinization of the commissural fibers and then of the cortical ones, an affection known under the name of Marchiafava-Bignami disease and which manifests itself through demented symptoms.

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The conclusion that can be drawn, as a result of the analysis of these psychic disorders caused by partial lesions on the callous body is that, if these lesions do not extend to neighboring structures, we cannot consider them similar to those determined by the callous disconnection syndrome.

In order to point out this syndrome, the agenesis cases of the callous body are more relevant. Considering the agenesis of the callous body a natural model of divided brain, some researchers have launched the hypothesis about the presence in this case of a callous disconnection syndrome.

The cases of clinical neuropathology have pointed out the fact that the congenital absence of the callous body determines a series of dysfunctionalities of the interhemispheric communication, of which the most obvious ones are the following: the diminution of the bimanual coordination and prehension; the slow way in which certain tasks of visual and tactile transfer are performed; the deficit in the evaluation of the distance between visual stimuli; the damage to the sound localization capacity.

Nevertheless, this casuistry has not fully confirmed the above hypothesis. With the exception of some particular cases, the subjects who present the agenesis of the callous body can react to the stimuli presented in each of the visual hemifields; they do not manifest either left tactile anomy or right-hand constructive dyspraxia. The above data point out the existence of some sole compensatory or in combination mechanisms, such as:

- bilateralization of the cerebral functions;
- use of "cross-cueing" behavioral strategies, which allow the unstimulated hemisphere to employ proprioceptive indexes derived from the answer supplied by the other hemisphere and thus secure a bilateral distribution of information;
- increased use of the ipsilateral ways in parallel with the normal use of the controlateral ways, allowing each hemisphere to have a bimanual representation;
- maximal use of residual commisures to secure the interhemispheric transfer (M.A. Jeves, 1986).

4. Conclusions

The experimental demonstration of the fact that the two cerebral hemispheres, similar as anatomic structure, develop, nevertheless, distinct functional mechanisms, has brought new and surprising perspectives on understanding the unity and emergence characteristics of personality in correlation with the neurophysiologic basis.

The anatomo-clinical and neurosurgical studies have pointed out the fact that the lesion in one or the other cerebral hemisphere determines different symptoms: the lesion in the left perturbs language and conceptualization, while the lesions in the right hemisphere affect extracorporal, corporal spatial data processing as well as the recognition of faces.

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The casuistry's research data in the field of neurosurgery have led to the formulation of the conclusion that from a functional point of view, the left hemisphere is much more differentiated, but at the same time, also more homogeneous, representing three specific cognitive mechanisms: *language*, supported by the activity of the temporal lobe, *calculation*, *praxis and somatognosia* supported by the parietal lobe and *visual symbolic functions,* supported by the occipital lobe.

At the level of the right cerebral hemisphere, the functional organization will be simultaneously weaker and more polyvalent in connection with a more primitively verbalized form of spatial relations.

The analysis of the contemporary neuropsychology data has imposed the idea of a direct correspondence between the anatomophysiological organization of the brain, the different types of tasks and the dynamic-structural organization of personality. These types of relations offer an objective basis for the understanding of the informational nature of the human psychic system and to explain the anticipative mechanisms of the human behavior.

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