Difficulties of neuropsychological diagnosis of unilateral neglect in the management of patients with ischemic stroke

Abstract. The article considers the topical problem of neurology, neurobiology and cognitive psychology — the question of pathogenetic mechanisms of origin and development of unilateral neglect after a cerebral infarction. The paper analyzes the scientific literature on the neuropsychological signs of hemineglect syndrome, its causes, features, manifestations and methods of rehabilitation. The role of the laws of neuroaesthetics in the perception and reproduction of environmental information in the brain is shown. New data on the peculiarities of the influence of the laws of neuroaesthetics on the process of the unilateral neglect formation are presented. It is emphasized that the principles of neuroaesthetics in oxidative stress after vascular catastrophe of the brain create conditions for the development of the pathological circle, the manifestation of which is lack of attention and loss of ability to respond to stimuli in one half of the field of view. It is determined that the exact neuroanatomy of unilateral neglect is complex and remains the subject of future researches for further cognitive rehabilitation of patients after cerebral infarction.

Keywords: unilateral neglect; hemineglect; neuroaesthetics; stroke; review

Unilateral neglect (or hemineglect) is a neuropsychological syndrome, the feature of which is the loss of the ability to respond to contralesional stimuli, despite intact sensory or motor nerve pathways [1–4]. In other words, visuospatial neglect of the opposite side of the focus develops, as well as ignoring and not realizing the motor deficit [5].

The causes for the development of the neglect phenomenon might be: cerebral infarction, traumatic brain injury, space-occupying lesion and brain surgery [2].

The most common cause of this syndrome is a stroke in the subdominant hemisphere (right) [6]. Hemineglect in the lesion of the left hemisphere is much less common [7–9] because it is the right hemisphere that plays a key role in the processes of attention [10]. The lack of compensation for right-sided damage is explained by the fact that the left hemisphere perceives only the opposite side of space, while the right hemisphere perceives both sides [11].

It is believed that a certain concentration and distribution of neurotransmitters regulate attention. This distribution is uneven in different hemispheres of the brain. The nor-epinephrine mediator system produces norepinephrine and serotonin, which are especially important for the processes of excitation and scanning the environment. This system is lateralized to the right hemisphere. The part of the thalamus that connects to the right hemisphere has a higher concentration of norepinephrine than the part that connects to the left hemisphere (Fig. 1). This asymmetry can be traced in the area of the cerebral cortex. Pathological processes in the structure of the right hemisphere damage to the norepinephrine mediator system. This damage reduces sensitivity and the ability to respond quickly to new environmental stimuli [10, 12].

There are several approaches to the classification of hemineglect syndrome. The unilateral neglect can be classified as egocentric or allocentric ignoring [14]. This classification is built based on the perception of spatial landmarks [10]. For a long time, it was considered that neuro-anatomically and pathogenetically these two processes are completely different [15]. However, over time, it turned out
that these different behavioral disorders have a single patho-
genetic mechanism [16].

In egocentric hemineglect, the midline is determined from the central axis of the patient’s neck, torso, and retina (spectator-oriented), whereas in allocentric hemineglect, the midline is determined from the central axis of the stimulus, regardless of its position in the environment (stimulus-orien-
ted). In the vast majority of patients with the phenomenon of ignoring, egocentric hemineglect is observed [14, 17]. In other words, a person with the lesion of the right hemisphere of the brain in egocentric neglect loses the ability to respond to information coming from the left side of the body, and in allocentric — the ability to respond to the left side of each object, regardless of the position of this object to the patient (Fig. 2). In some patients, both of these variants with diffe-
rent degrees of manifestation may be observed [10].

The neglect syndrome can also be classified into sensory, motor and representative. Sensory, in turn, can be visual, de-

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Neuroaesthetics generally refers to the study of the neural foundations of beauty by understanding the mechanisms underlying the brain’s response to art. The main purpose is to determine the nerve correlates associated with aesthetic experiences [26]. There are more and more new researches and discoveries every year, which undoubtedly indicate the relevance of this issue and its further potential [21]. Nowa-
days, neuroaesthetics is not limited to the accumulation of knowledge only through the prism of art but includes a large number of scientific works, the practical significance of which is the use of its achievements in many fields, including health care.

It is proved that the feeling of beauty is natural, as it is provided by universal innate mechanisms of visual sen-
sation. Since this process is not acquired, it occurs by default, regardless of the person’s wishes. Therefore, depending on the situation, interpretations and judgments that arise in the brain as a result of perception can be a source of pleasure and relieve stress or, conversely, suppress and cause discomfort [22, 23].

If we are based on the doctrine of neuroaesthetics, then some of its laws can explain the mechanisms of development of unilateral neglect. So, one of them is the law of attraction to symmetry. Evolutionarily, the entire organism is built on the principle of bilateral symmetry, and asymmetry is associ-
ated with infection and disease [24], so it is less attractive for perception by our nervous system. Hence our innate desire to prefer something proportional and symmetrical. After a vascular catastrophe, a unilateral neurological deficit devel-

Under conditions of oxidative stress, in which the brain is after a stroke, it becomes much more difficult to provide the basic primary properties of attention (sta-
bility, volume, distribution, selectivity and concentra-
tion) [25]. In this case, another law of neuroaesthetics is connected — isolation of one module and distribution of attention [24]. The subconscious, which is already try-
ing to ignore the asymmetric neurological deficit, begins
to focus on the healthy side and allocate it as the main module of perception.

The pathological circle of unilateral neglect from the standpoint of neuroaesthetics is fixed by the principle of peak displacement. In other words, the signal gains in the selected modality. As a result of redistribution and concentration of attention on one healthy side, hyperbolized perception of stimuli by sensory systems develops, and this leads to greater aesthetic pleasure than from stimuli under normal conditions. Vilayanur Ramachandran called this process of exaggerated perception a “superstimulus”.

However, there is a great deal of heterogeneity in neuroscientific researches on neurological correlates related to aesthetic experiences (e.g., evaluation and perception of attractive stimuli). This discrepancy is usually explained by the lack of consensus on the definition of “aesthetic experience”. Usually, trying to understand the biological and neural basis of aesthetic experience, to explain how aesthetic experiences are created in the brain, and to use our knowledge of brain mechanisms to inform our understanding of these experiences is certainly a necessary step. In this sense, the contribution of neuroaesthetics is crucial in shaping the understanding of aesthetic experience. However, the precondition for this is that neuroaesthetics becomes more critical and contextualized [26, 27].

Summarizing all the above, unilateral neglect (or hemineglect) is a complex heterogeneous neuropsychological syndrome, the final pathogenetic mechanism of which is not fully understood and has a large basis for further researches. Using some laws and principles of the modern discipline of neuroaesthetics, we can use neurobiological and psychological processes of the brain’s perception of beauty to try to explain the “interest” of consciousness in unilateral neglect.

The laws of peak displacement (or “superstimulus”), isolation, symmetry of neuroaesthetics make it possible to understand the biological and neural basis of the brain mechanisms of hemineglect syndrome, as well as their role in reducing shock to the patient’s mind under oxidative stress.

Further researches contextualized in this direction will significantly increase the effectiveness of rehabilitation of patients who have suffered from a brain infarction, the level of their social and household adaptation and, accordingly, the quality of life.

Conflict of interest. The authors declare the absence of a conflict of interest in the preparation of this article.

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Складнощі нейропсихологічної діагностики синдрому неглекту в рамках менеджменту пацієнтів з ішемічним інсультом

Резюме. У статті розглядається актуальна проблема неврології, нейробіології і когнітивної психології — питання патогенетичних механізмів виникнення та розвитку одностороннього неглекту після інфаркту мозку. Проаналізовано наукову літературу щодо нейропсихологічних ознак синдрому гемінеглекту, його причин, особливостей, проявів і методів реабілітації. Показано роль законів нейроестетики у сприйнятті і відтворенні інформації про довкілля в мозку. Наведені нові дані про особливості впливу законів нейроестетики на процес формування одностороннього неглекту. Підкреслюється, що принципи нейроестетики при окиснювальному стресі після судинної катастрофи мозку створюють умови для розвитку паіологічного кола, проявом якого є відсутність уваги та втрата здатності реагувати на подразники в одній половині поля зору. Визначено, що точна нейроанатомія одностороннього неглекту є складною і залишається предметом майбутніх досліджень для подальшої когнітивної реабілітації пацієнтів після інфаркту мозку.

Ключові слова: односторонній неглект; гемінеглект; нейроестетика; інсульт; огляд

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