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The structure of the brain and human behaviour

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Abstract

Currently, the state of knowing the structure and functionality of the human brain is a source of interest for many researchers. Despite the fact thet there are significant advances in neurobiology, there is still a lack of information on neuroanatomy and neurophysiology that could shed a new look at interpersonal behavior. Changes in the structure of the human brain, which may occur as a result of various factors, affect its functioning and thus human behavior. In the context of neuroanatomic and metabolic changes, cognitive functioning, as well as the expression and control of emotions are also modified. It is worth noting that during the adolescence period, the human nervous system is particularly sensitive to injuries, and dysfunctions of the brain structures that can interfere with for overly risky or even aggressive behavior. The aim of this work was to determine the basic anatomical structures in the functional aspect conditioning human behavior.

Keywords: brain, neuroanatomy, neurophysiology

Introduction

The question about the phenomenon of the human brain is still valid today. Comparing the state of knowledge regarding the structure and functionality of the human brain to previous centuries, it is currently at a higher level, actually neuroanatomy and neurophysiology and mechanisms conditioning human behavior is still missing. The complexity and uniqueness of the human brain is an inspiration for multidirectional research for scientists from various fields of science. Advances in broadly defined neurobiology and close neurophysiology lead us to the idea that physical characteristics influence our behavior. Other research results indicated structural changes in the brains of psychopaths, compared to healthy individuals. The key issue is the relationship between human behavior, the construction of his brain and the environment in which he exists. The modern theory of "bad brain leads to bad behavior" (A. Raine, University of Pennsylvania) has more and more supporters [1-5].

Purpose of work

The aim of this work was to determine the basic anatomical structures in the functional aspect conditioning human behavior.

Description of knowledge

3.1 Functional neuroanatomy of the human brain

The central nervous system (central) is located in the skull cavity and the spinal canal, it consists of the brain (Figure 1) and the spinal cord. The following parts are distinguished in the brain (in order from top to bottom) [6]:

• telencephalon (1);

• diencephalon (2);

• mesencephalon (3);

• rhombencephalon (4);

• myelencephalon (5).

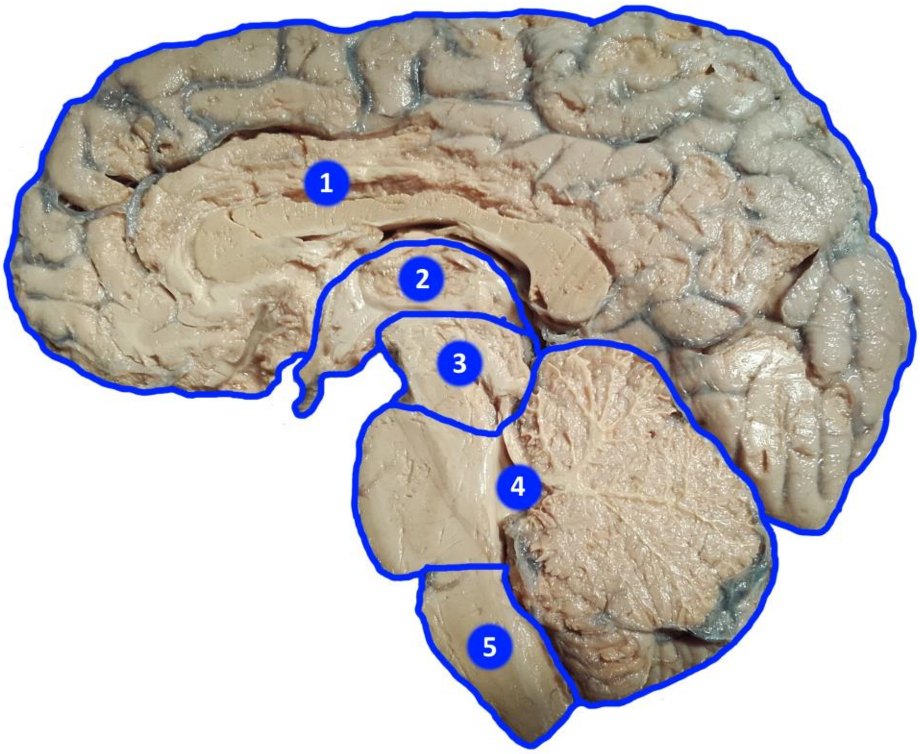

Figure 1. Hemisphere of the right brain in the sagittal section. Description of structures in the text above [own elaborations].

The cerebrum is composed of two cerebral hemispheres (differing morphologically and functionally), which are divided into lobes delimited from each other by furrows. Externally the hemispheres cover the cerebral cortex, the so-called gray matter, which is composed of several layers of nerve cells with a different shape, while the inner layer of hemispheres is a white matter in the composition of which the nerve fibers associate, commissive and projective. The cerebral hemispheres are separated by the longitudinal slot of the brain, on the bottom of which the corpus callosum is located, which is a white matter band, which is designed to connect the two hemispheres of the brain [6-7].

The right cerebral hemisphere processes the information in a holistic way, all the attributes of the stimulus are understood comprehensively and simultaneously, regardless of the time course. The left cerebral hemisphere processes the information in an analytical way (sequential), on the path of perception of the next elements, whereas the systematization of the material is strictly dependent on the passage of time [8].

<u>Features of the right hemisphere</u> [8-12]:

- receives spoken and spoken words;
- controls the reading direction;
- manages the statement based on prosodic features;
- understands the context of speech;
- guides orientation processes to new stimuli;
- identifies stimuli based on physical similarity;
- processes spatial information, including identify faces;
- receives and stores music and mathematical information;
- receives information covering feelings, mainly negative (in relation to the left hemisphere has more connections with the limbic system);
- recognizes geometrical figures and basic characteristics of stimuli;
- receives stimuli containing an emotional charge;
- understands facial expressions and regulates the emotional expression of the face;
- distinguishes gestures expressing emotions;
- classifies emotional information in relation to social communication.

<u>Features of the left hemisphere</u> [8-12]:

- receives, recognizes and differentiates speech sounds;
- performs a number of verbal operations in relation to the activity of the frontal cortex;
- controls analytic and relational functions;
- processes information sequentially;

- receives and stores known stimuli;
- identifies stimuli using logic compounds;
- compares the stimulus to the principle of determining the relationship between them;
- records the elapsed time;
- organizes memory in relation to general knowledge about the world;
- concentrates attention.

The cerebral hemispheres are divided into lobes, four in each of them. Taking into account the anatomical and physiological studies, it was shown that individual lobes are associated with specific functions, which are presented in table 1.

Table 1. Lobes of the cerebral hemispheres and their functions

Lobe of the brain	Functions
Frontal lobe	• planning and execution of any movements; • eye movements; • responsibility for, among others: thinking, concentration, information processing, matching facts, drawing conclusions and making decisions; • responsibility for learned memory; • speech expression; • control and evaluation of emotions; • assessment of social situations and adjustment of their behavior to them; • anticipating the consequences of your actions, • having pleasure in satisfying the drives; • feeling anxious and frustrated.
Temporal lobe	• speech control; • responsibility for verbal memory and remembering; • object recognition; • reception of sound impressions; • odor analysis.
Parietal lobe	• the feeling of touch, temperature, pain; • the concentration of sensory impressions; • spatial orientation; • coordination of finger movements; • linking movement and vision to the same impression; • space and movement coordination; • understanding of symbolic language, abstract and geometric concepts.
Occipital lobe	• analysis of color, motion, shape, and depth; • vision and visual associations; • sensation assessment; • interpretation and classification of impressions.

Source: Own study based on [6-7, 12]

Diencephalon it is part of the forebrain, located between the front and posterior brain. It covers the hill, hypothalamus, hypothalamus, located in the vicinity of chamber III. It determines the fulfillment of all activities dependent on the autonomic nervous system. Intergranate comes from the second pair of cranial nerves or optic nerves. In the area of topographic anatomy, there are also associated glands associated with it, such as the pituitary gland and pineal gland. The hypothalamus is connected by the nervous pathways with the cerebral cortex and all areas of the organism [6-7].

Mesencephalon includes the cerebral peduncles and the midbrain cover, connects the interbrain with the bridge and the cerebellum. In its structure, it contains a lot of gray matter. Midbrain is an important place from the perspective of the nerve pathway connecting the cerebral hemispheres with the perimeter of the body and contains cranial nerve nuclei III and IV. In functional aspect [6-7]:

• includes associative centers for vision and reflex centers for sight and hearing, which are subordinated to the upper floors of the brain;

• participates in the coordination of internal organs as part of the parasympathetic system;

• participates in the coordination of skeletal muscle movements.

Rhombencephalon in the anatomical structure, it is made up of a bridge and a cerebellum. Within the bridge, the dorsal surface (the medial-lateral median, the creator and the body of the quadruplets) and the basal one in which the fibers run and the irregularly distributed nerve cells are distinguished. In reticular formation there are circulatory centers associated with gastrointestinal function and regulating skeletal muscle tone, as well as cranial nerve nuclei are located:

• facial;

• vestibularcochlear;

• trigeminal.

Nerve fibers run through the bridge connecting the cerebral cortex to the medulla, spinal cord and cerebellum [6-7].

The cerebellum, located at the bottom of the skull, under the occipital lobes of the brain. Two hemispheres are distinguished in the construction and worm in the middle part. A characteristic image of the so-called the tree of life, the perpetuation of the longitudinal section through the cerebellar worm arises. The outer part of the cerebellum is covered by a gray creature called the bark of the cerebellum. In the construction of the cerebellum there is the Varola bridge, which is a structure made up of cranial nerve nuclei and nerve fibers connecting the core with the brain and subcortical centers and other parts of the nervous system. Due to the functionality, the cerebellum is responsible for [6-7]:

• body balance control;

• motor coordination;

• maintaining constant muscle tone.

Myelencephalon is the lowest part of the brain, which is the extension of the spinal cord. It plays an important role in the vegetative system, because it is concentrated in many nerve centers responsible for the work of internal organs. In the brain, nerve centers corresponding to reflex reflexes such as [6-7, 12] are located: breathing, ingestion, suction, cough, sneezing, blinking, etc.

3.2 Emotions and limbic system

The limbic system is the part of the brain that is responsible for experiencing and processing emotions. It also plays an important role in the emergence of cognitive and decision-making processes, appetite and sex drive.

The limbic system consists of [6-7, 12]:

• amygdala;

• hippocampus;

• cingulate cortex;

• hypothalamus;

• thalamus.

Information from the senses (excluding smell) goes through the thalamus, and then they are processed in parallel in two ways [7, 12-13]:

• low (directly from the amygdala);

• high (from the thalamus to the neocortex, and then to the amygdala).

With regard to the course of information on the "low way" principle, this refers to a quick reaction in cases of life-threatening. It consists of comparing the current stimulus with the amygdala found in the memory of the body. The speed of response in such cases is characterized by accuracy, it is justified by omitting the analysis in the bark, although it may be inadequate to the situation. The existence of this path explains the habitual, ill-conceived emotional reactions and the mechanism of formation of anxiety disorders [7, 12-13].

In less extreme situations, information flows on the "high way". Areas of the prefrontal cortex, responsible planning and working memory, allow a complete analysis of the stimulus, thus planning the action. As a result of a careful analysis of the stimulus, the amygdala activity decreases and the autonomous response decreases, while the activity of the prefrontal areas and the cingulate cusp increases simultaneously [7, 12-13].

The neocortex is mainly responsible for higher cognitive processes, with respect to emotions, prefrontal areas that play an important role in cognitive emotion control are particularly important. The functionality of the amygdala is a conditional creation and remembering of emotions, while the episodic memory, that depends on context and learning, is answered by the hippocampus, which stimulates the bark and regulates emotional reactions with the prefrontal cortex, amygdala and hypothalamus. Hippocampus allows you to remember the facts, while the emotional color gives them the amygdala. In the matter of consolidation of memory traces and awareness of psychological processes, the crucial role is played by the bend of the rim, which activates in describing feelings, whereas referring to the neurohormonal aspect related to the emotionality of the human being plays a key role the hypothalamus from which information is sent to the pituitary gland, which in turn controls secretion of the majority of hormones and the sympathetic and parasympathetic system. For example, when there is a danger situation, there is an increase in adrenaline and cortisol in the blood, and thus there are vegetative changes manifested by muscle contractions, breathing acceleration, etc., this is of course related to the reaction of escape or defense [7, 12-14].

The formation of emotions takes place in a loop, called the Papez's circle beginning with the nucleus of the hypothalamic body of the hypothalamus, which is the starting element for expressing emotions. Information from the mammary bodies reaches the anterior part of the thalamus and the cingulate cortex, in which feelings arise, while the cingulate cortex sends projections to the hippocampus, which then integrates various signals and directs them to the mammary body [15-16].

In the years 1949-1970, Paul MacLean developed the theory of the limbic system as a system responsible for emotions. The aforementioned Papeza circle has been extended by such structures as [17]:

• cortex around olfactory;

• entorhinal cortex;

• cortex around hippocampus;

• amygdala;

• prefrontal septum;

• prefrontal cortex.

In the MacLean theory, the hippocampus was understood as the structure responsible for the analysis of unconscious associations, whereas experiencing and expressing emotions resulted from the association of internal and external stimuli [17].

Joseph LeDoux criticizes the concept of the limbic system, describes it as "foggy" and identifies with most subcortical centers above the brainstem; it also emphasizes the very importance of the hippocampus, which does not take part in emotional reactions, although originally thought to be part of the limbic system [18].

3.3 Neurobiology of human behavior

Many years of research and clinical observations provide important information on brain injuries, at the level of the first periods of human life, i.e. experiences during pregnancy, delivery or childhood (up to 7 years of age), which may have been caused by various factors and ultimately cause permanent defect the brain in a structural and functional dimension, and ultimately significantly affect the development of personality [19].

In the context of neuroanatomic and metabolic changes, cognitive functioning as well as the expression and control of emotions are also modified. It is worth noting that during the adolescence period, the human nervous system is particularly sensitive to injuries, and the dysfunctions of the brain structures that can interfere with for overly risky or even aggressive behaviors [20].

In the aspect of the inclination of impulsive, risky and aggressive behavior, there is an advantage of young men in relation to women, the justification for this sexual relationship, are the size of the limbic system and the activation of the frontal lobe area. In order to confirm the above statement, several examples are given below [20-27]:

• the tailed part and the left pale knot is much smaller in volume in men (compared to girls of similar age), which results in impaired impulse control;

• the area of the hippocampus is relatively larger for adolescent girls than for boys of similar age;

• amygdala area is strongly developed in boys compared to adolescent girls of similar age, perhaps these developmental conditions are related to the higher prevalence of some neuropsychiatric disorders among boys, eg. ADHD, Tourette syndrome and obsessive-compulsive disorder;

• less amygdala in girls may be the basis for more frequent occurrence of anxiety disorders;

• a higher level of activation of the frontal lobe area in boys during adolescence than in girls, which is manifested by a greater tendency to aggressive behavior, addiction and risk-seeking;

• a higher level of activation of the prefrontal cortex (the area responsible for inhibition of impulses and self-control) observed in girls, explains to them greater emotional and cognitive maturity in relation to boys of the same age.

It is worth paying attention to the importance of the prefrontal cortex, which is important in the process of aversive condition and stress response. The prefrontal cortex plays a fundamental role in regulating the physiological arousal of an organism, the damage to this area determines the need for seeking sensations and the tendency to exhibit risky behaviors, additionally they make bad decisions even when they are aware and able to make a better choice. People diagnosed with defects in the prefrontal cortex are characterized by [28-31]:

• impulsivity;

• breaking norms;

• recklessness;

• irresponsibility.

Conclusions

Today, much attention is devoted in world and Polish literature to the search for a connection between brain dysfunctions and human behavior. Numerous studies indicate a decreased activity of the prefrontal areas of the brain, with simultaneous increased activity of subcortical structures, which undoubtedly affects an increased tendency to aggressive behavior, to a large extent of an impulsive or reactive nature.

In the aspect of the complex issues of the issue, as well as the description of the mechanisms of the impact of brain disorders on aggressive behavior, there is still a lack of information that would allow a full analysis and explanation of the causes of these pathological phenomena.

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