

# Cognitive Processes of the Brain and Learning Theory

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**Abstract.** The article deals with the cognitive processes of the brain and their interaction with the most common theories of learning. A brief scientific history studying brains is presented, the choice of cognitive processes investigation methodology is proved. The authors hold a view of the famous English mathematician and cosmologist Roger Penrose. His methodological approach resides in the idea that all processes occurring in the brain are the main natural phenomena, so studying of them should become the most important part of interdisciplinary research in physics, mathematics, biology, philosophy and psychology. The interrelation of the process of learning with the quality of brain activity alongside with its structure and functioning is examined. In conclusion stages of human creativity, cognitive processes mechanisms are provided evidence based on the standpoint of specific nature of brain functioning.

## 1. Introduction

The specific character of biological processes lies in the fact that they are not determined by physical laws, but they are a consequence of vital activity genetic programs. This means that despite their occurrence according to physical laws, their results are defined not by these laws, but by the genetic program algorithms arranging the sequences of natural material processes [4; 13].

Concerted efforts and precisely coordinated work of all structural elements in all biological systems, their stable interaction with the external environment and functioning in strict accordance with the vital activity genetic programs, is provided by special splanchnological controlling functions of the organism with the brain being in the center of the control that is a typical feature of all higher animals and human beings [5; 12].

## 2. Methods

The first mention of the human brain was discovered in the records of the Sumerians, carved on clay tiles about 4000 years BC. Ancient Egyptians did not consider brain the main controlling body and paid more attention to the heart. However, Plato came to the conclusion, which resonates with contemporary views concerning human brain functioning. He was one of the first to point out that the human brain is the "birthplace" of mental processes. Aristotle studied the process of sleeping and dreaming, but he considered them not to be the work of the brain, but connected these processes with soul and heart. The science of the human brain was significantly advanced by the famous Roman doctor Galen. He, in particular, guessed that different parts of the brain are responsible for performing different functions.

The work of the human brain was studied by many medieval doctors. The first attempt to create gnosology connected with the capabilities of brain, was done in the 17th century by John Locke, a famous philosopher, then it can be found in A. Leeuwenhoek's work devoted to nerve fibers. In 1863 the Russian physiologist I. M. Sechenov put forward the theory of reflexes. Later this theory was developed by academician Pavlov.

Philosophers of the 19th century split down the middle on the issue, they were either idealists or materialists. Idealists believed that the world around us is incorporeity creation of human consciousness. Materialists shared the point of view that mind, consciousness and thinking are the material products of the brain. Marxists in their turn hold the opinion of unsubstantiality of consciousness but considered it a derivative of the materia. This idea has been still existing since that time. Those sticklers for the exact Sciences, such as scientists of physics and mathematics, believe that all the processes functioning in the brain can be explained by philosophers. This point of view is argued by the famous English mathematician and cosmologist Roger Penrose [20], who considers the processes taking place in the brain to be the basic natural phenomena. That is why their study should become an important part of physics, mathematics and biology.

Two decades ago, Penrose together with the anesthesiologist Stuart Hameroff, laid the foundations of the theory investigating human brains and consciousness. One of its assertions implies the existence of quantum states that resist the disruption of neural connections in the internal structure of neurons caused by the interaction of the system with the external environment. In the latest article concerning their theory, scientists confirm that they have managed to find strong arguments in favor of this hypothesis. Despite the fact that both of them are highly respected in the Academe, their ideas are still regarded skeptically. Penrose's approvals mean, ultimately, that consciousness cannot be narrowed down to the execution of certain algorithms. It coincides with our point of view that is the admission of the fact that consciousness is of the intangible nature. As for the rest the cerebration is perfectly explained by the laws of physics, in particular, at the level of neural connections.

We cannot help but mention the works of the following Russian scientists such as Professor of St. Petersburg University, Doctor of Science Chernigovskaya and Professor Savelyev, who are popular among the audience of modern neurologists adhering to the opposite opinion. The concept of Chernigovskaya makes fetish of the brain. From her point of view, the brain is a mysterious, independent structure, neither subject to human's control nor associated with his personality [10].

Unlike Professor Chernigovskaya, Professor Savelyev considers cerebrum to be just an ordinary physical system or a complex but far from perfect machine. According to him human brain differs from the animal brain in the number of neurons. The evolution of the brain is narrowed down to a gradual increase in its size and respectively it leads to raising number of neurons. Savelyev prooflessly denies the influence of lateralization of brain function on its functioning [21].

In our opinion, Penrose is the closest to the truth [20], though his concept is controversial enough, especially when it concerns quantum theory dealing with the creation of new kind of physics, that is physics of mind, which is aimed to explain all what is now considered inexplicable. To confirm our approach, we will consider the structure and functioning of the brain in detail.

### **3. Results and Discussion**

Brain is connected with all controlling and structural elements of the body, it coordinates and synchronizes their activities, performs the functions of a chief controller or being like a "maestro di cappella" arranges and organizes the work of a huge, highly organized and complex ensemble of neural network and living cells which are combined in the organism [11; 18]. Due to its interaction with the internal and external environment, it collects and keeps all the information, provides its processing and use.

Human cerebral differs from animals' one owing to a higher level of human organization and, accordingly, by additional functions of intelligent intellectual activity [7; 8; 19]. Besides regular functions typical for all animals such as organization and control of the processes of vital activity of the body, including, metabolism, processes of reflectivity and perception of reality, as well as reproduc-

tion, adaptation, self-preservation, etc., there are the functions peculiar to homo sapiens's brain, namely: insight and theoretical perspective and thorough understanding of reality on the basis of logical and abstract conclusions; creative activity arrangement and ability of surrounding reality transformation based on the use of gathered and stored information obtained due to practice and owing to process of learning and studying of the world; the ability to be in control of psychophysical activities alongside with volitional and behavioral processes, capability of emotional and spiritual sphere interaction, bringing under control interaction with the external environment on the basis of communication, mental activity, reasonable communal and social activities.

Cerebrum consists of several parts and it is neencephalon (great brain) that performs the most intelligent functions, then there is a brain stem part with midbrain and hindbrain being combined in it and brain axis. This connects cerebrum and spinal cord in its turn and consists of rachidian bulb (medulla), mesencephalon (midbrain) and diencephalon (interbrain). The latter is made of thalamus providing body adaptation to the external environment, and the hypothalamus regulating vascular glands. Hypophysis (pituitary gland) goes to make up hypothalamus and maintains body temperature, besides being "responsible" for the heart and digestive system functioning as well as sleep and wake. The hindbrain includes the cerebellum or little brain that regulates coordination of movement. Finally, the medulla coordinates balance, metabolism, blood circulation, breathing, coughing and sneezing.

The neencephalon (great brain) consists of two hemispheres, left and right, which are connected by the so-called corpus callosum. The left hemisphere controls the right half and the right half controls the left half of the body. All humans, unlike all animals, have asymmetrical hemispheres so left and right hemispheres are "responsible" for performing completely different functions.

People are divided into two types that means they can be either artistic or rational. So the right hemisphere is considered to be of an imaginative or emotionally artistic type because of its way to acquire information. Therefore people of the artistic type have the right hemisphere dominating the left. They are notable for developed spatial intelligence, having aptitudes and ear for music, good musical memory. Such people are distinguished by vivid figurative and artistic perception. They are also characterized by being receptive to quiet sounds, deeper olfactive sensations and color shades perception. Among them you can find a great number of composers, artists, actors, poets and writers, architects, designers and inventors, scientists.

The left hemisphere of the human brain is called verbal, logical or mathematical one. It has a greater neuron density in association areas which are "responsible" for the intellectual functions of a human being. So the most outstanding, brilliant individuals can appertain to both artistic and rational type. The deviation in symmetry is known to be the mover and motivation in the evolution. This means, in our opinion, it is the asymmetry of the brain that is the main reason and factor of homo sapiens's existence.

Relatively speaking it is subcortex that is at the forefront of unconsciousness, while association cortex is associated with consciousness. If we assume that the average number of connections per neuron in human brain is 10,000, the total number of connections, most of which are located in the subcortex, is 860 trillion. This provides the human unconsciousness functioning at the high speed response of 109 bps.

Consciousness is more rational, but many times slower than unconsciousness, having only 103 bps' speed response. Many a man believe that it is caused by dendrites low conductivity of electrochemical signals taking place in association cortex which is actually consciousness. From our point of view, this opinion is wrong. The density of neurons, and, consequently, their connections being formed by the shorter dendrites in association cortex is rather high exactly. And what's the point of abating conductivity in these high value areas in terms of nature? The low speed response of the association cortex is the result, in our opinion, of their high intellectual power, ironically. Indeed, in order to make the best logical decision, the consciousness analyzes received information over the long haul, comparing it with the huge amount of stored information that is kept in the relevant association areas and having been obtained through practice and training. It seems to us this comparison takes place according to the scheme of the simplest logic reasoning like "if...then". The denser the neurons are located in the

association cortex, the higher the degree of its associativity, the greater variety of options are analyzed, the more optimal and logical decision is made. It takes much time to view and search all possible options, that is why the speedwork of consciousness is dramatically reduced.

It should be noted that the information enters the mind not directly, but either from the right hemisphere of the brain or associative memory. A big part in making a decision by consciousness in response to the received information is played by sentiment (emotional coloring) of coming from the right hemisphere signals. If the right hemisphere dominates, while intellectual abilities of the left hemisphere are degraded, in that case negative emotions are not suppressed by the left hemisphere, and consciousness under their influence often makes wrong decisions contradicting logic. This is the way of moral decay, criminal activity, terrorism, the appearance of antisocial personalities. The same proceeds to the collective consciousness under the influence of negative public emotions [2; 6].

#### **4. Conclusion**

Due to everyday experience human activity processes of thought are arranged by followed in a specific order ideas [1; 9; 15; 16; 17]. They find the most meaningful expression in creativity. Creativity is conveyed in the following stages: 1) ambitions are determined by the ideas based on experience in combination with corresponding thoughts 2) the intention is actualized on the basis of ideas arising from ambitions; 3) programming is carried out using the ideas of the intention; 4) designing is a result of the program perceiving and its materialization (creation of a set of drawings and program implementation technology); 5) implementation is a project program manifestation.

Thus, the most important required step in the creative process is the materialization of the preceding ideas, which come true in two stages [3; 14]. At the first stage, ideas are transformed into information that duplicates all the algorithms inherent in them via material means. The second stage is actualized in different ways in diverse processes. In the process of transformation of reality as it is there is a transition of ideas into material objects in accordance with above-mentioned technology, while in cognitive processes of the information obtained at the first stage the appropriate memory cells of the brain are formed and derived from there for further use if helpful. These features of the creativity stages in regard to cognitive processes must be taken into account in the formation of learning theory.

#### **References**

- [1] Baayen R H, Hendrix P January, 2011 Sidestepping the combinatorial explosion: Towards a processing model based on discriminative learning LSA workshop: Empirically examining parsimony and redundancy in usage-based models
- [2] Baksanskij O E, Gnatik E N, Kucher E N 2010 Nanotechnology. Biomedicine The philosophy of education In the mirror of an interdisciplinary context *Librokom Publ.* (Moscow)
- [3] Baksanskij O E, Gnatik E N, Kucher E N 2008 Natural science: modern cognitive concepts (URSS, Moscow)
- [4] Baksanskij O E 2009 Cognitive representations: ordinary, social, scientific (URSS, Moscow)
- [5] Baksanskij O E 2012 Methodological foundations of modern education modernization *Philosophy and culture* vol 9 105-111
- [6] Berger P, Lukman T 1995 Social construction of reality A treatise in the sociology of knowledge (Medium, Moscow)
- [7] Brown G D A, Neath I, Chater N 2007 A Temporal Ratio Model of Memory *Psychological Review* **114(3)** 539-576
- [8] Brown S D, Steyvers M 2009 Detecting and Predicting Changes *Cognitive Psychology* (**58**) 49-67
- [9] Chang F, Dell G S, Bock K 2006 Becoming Syntactic *Psychological Review* **113(2)** 234-272
- [10] Chernihovskaya T V 2013 Cheshire smile of Schrödinger's cat: language and consciousness *Languages of Slavic culture* (Moscow)
- [11] 2011 Cognitive psychology. History and modernity Chrestomathy (Lomonosov, Moscow)

- [12] Demidenko E S 2016 The Concept of Technogenic Social Development. SHS Web of Conferences *RPTSS 2015 – International Conference on Research Paradigms Transformation in Social Sciences 2015* (28) DOI: <http://dx.doi.org/10.1051/shsconf/20162801025>
- [13] Dergacheva E A, Baksanskij O E 2016 Economic Man under Conditions of World Social-Technogenic Development The European Proceedings of Social & Behavioural Sciences *International Conference «Responsible Research and Innovation 2016»* 192-200 <http://www.futureacademy.org.uk/files/images/upload/icRRIF2016025.pdf> <http://dx.doi.org/10.15405/epsbs.2017.07.02.25>
- [14] Dergacheva E A, Baksanskij O E 2016 Socio-techno-natural reality: socio-economic risks of convergence *Fundamental research* vol 12-3 612-617
- [15] Meskov V S, Sabadini N R, Smirnova I V (ed.) 2018 Essays in cognitive science: cognitive studies as the bases of pedagogics Monograph on the results of International scientific-practical conference "Cognitive studies as the basis of pedagogy" (Moscow State Pedagogical University, the Institute "graduate school of education" Educational-scientific center of interdisciplinary education and co-nativistic April 22, 2017 Moscow, Russia) (KnoRus, Moscow)
- [16] Fific M, Little D R, Nosofsky R M 2010 Logical-Rule Models of Classification Response Times: A Synthesis of Mental-Architecture, Random-Walk, and Decision-Bound Approaches *Psychological Review* **117(2)** 309-348
- [17] Kolesnik T A 2017 Technocratic nature of education in the market. Economy in the conditions of social and technogenic development of the world 2nd International interdisciplinary scientific conference on fundamental and applied problems of modern socio-economic and economic-ecological development Bryansk State Technical University Russian Academy of Sciences (1) 118-125
- [18] Krol V, Vika 2014 M.: Psychophysiology (KnoRus, Moscow)
- [19] Markov A V 2014 Human evolution Monkeys, neurons, and soul vol 2 (AST, Moscow)
- [20] Penrose R 2007 Path to reality, or Laws governing the Universe Regular and chaotic dynamics (Institute of computer science, Moscow)
- [21] Savelyev S V 2014 Poverty of the brain (Vedi, Moscow)