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Neuro-Linguistic Mechanisms of Innovation Identification in the Binary Substance of the Brain

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Abstract

This article is devoted to the study of neural mechanisms of the binary substance of the brain in the process of detection and identification of innovation. The relationship and interdependence of genetically determined neural structures in the subcortical sphere and mental mechanisms of codification in the neocortex are shown.

Keywords

Subcortical Sphere, Innovation Detection, Innovation Identification, Mental Mechanisms, Codification Mechanisms, Neocortex, Genetically Determined Neural Structures

1. Introduction

Currently, when there is an increasing interest in the phenomenon of natural and artificial intelligence (artificial intelligence, AI), there is a need for scientific identification of all aspects of human cognition, including the mechanisms of creative thinking in the process of searching, discovering and scientific identification of innovations. It should be noted that when studying creative abilities, research is most often aimed at identifying the process of cognition in the neocortex (cortex), and the functioning of the neural network of the subcortical sphere is covered only within the framework of natural science as a purely biophysiological process.

The aim of this study is to investigate the neural mechanisms of identifying novelty (innovation) in the binary (subcortical sphere and neocortex) substance of the brain, the features of the interaction of neural structures of the deep sphere and the brain shell.

There is no doubt that cognitive activity in general and creative activity, the highest form of which is innovative activity aimed at detecting and identifying innovations, are related to the functioning of the cerebral cortex. The role and activity of subcortical nuclear structures of the brain in this creative process remains insufficiently investigated. This raises a reasonable question about how the subcortical substance of the brain, as a genetic entity in which human abilities for language, thinking, and metality do not manifest themselves, appropriately perceives non-specific information coming from the neocortex (upper brain shell) and it ensures the process of purposeful creative activity of a person. An adequate answer to this question requires consideration of the problem at the junction of a number of social sciences, humanities, natural sciences, identification of neurolinguistic foundations of the creative process.

2. Literature Review

This problem is currently being investigated at an interdisciplinary level within the framework of natural and social sciences and humanities (Merton & Barber, 2004). The outstanding French philosopher and sociologist E. Morin, relying on transdisciplinary research, defends the idea of the need to reform thinking by radically changing the method of cognition. He interprets creative thinking as a divergent, diverse, flexible, sensitive to new things and able to innovate way of creative cognition.

Despite significant progress in the study of the brain in recent years, much of the scientific identification of the functioning of the cortex and subcortical sphere as a whole still remains an insufficiently researched area of knowledge. The functioning of individual neurons and complex structures of neural cells is well explained, but understanding how the brain functions as a whole as a result of the interaction of thousands and millions of neurons in the social sciences and humanities, in particular, in psycholinguistics, is limited to the study of the mechanisms of the neocortes (cerebral cortex), which requires further in-depth research to identify the binary paradigm of the brain substance. research. Speaking about the participation of the subcortical sphere in the creative process, it can be noted that, compared with studies of the neocortex, the identification of this purely genetically determined area of the brain is carried out only within the framework of natural sciences.

The main forms of creative activity are serendipity as an instinctive (intuitive) insight, which means the ability to draw deep conclusions from random observations and find something that insight did not intentionally seek, insight is the sudden conscious finding of a solution to a problem that resulted from prolonged unconscious mental activity (Weisberg & Alba, 1981). In the vast majority of cases, when identifying the implicit sides of an activity, the authors limit themselves to mentioning that insight as a hidden discourse is "a way of approaching, cultivating and using happy coincidences." (Christian, 2022)

Consideration of the issues of deep genetically determined mechanisms of con-

sciousness, intelligence and language, which play a crucial role in innovation in the framework of psycholinguistics, will be insufficient, since the concepts of this science are limited to the consideration of mental mechanisms occurring in the neocortex. With such an examination, the problem of the interrelation and interdependence of the genetically determined subcortical sphere and the neocortex requires close attention. Analysis of the mechanisms of functioning of deep structures in the nuclear sphere of the brain and surface structures in the neocortex as a neoplasm will to a certain extent contribute to the scientific identification of brain phenomena, in particular, the essence of the unconscious, which is interpreted as a set of mental processes and phenomena outside the sphere of consciousness of the subject, that is, for which there is no control of consciousness. According to Freud, it is the unconscious that has the strongest influence on human behavior (all behavioral automatisms, scenarios, learned roles are "stored" there). The scientist compares the unconscious to the underwater part of an iceberg—no one sees it, but it contains the most information about a person's personality (Sigmund, 2022).

As you know, Carl Gustav Jung, within the framework of the discipline he created—analytical psychology—introduced the term "collective unconscious", and significantly changed its meaning in comparison with psychoanalysis (Jung & Carl, 1967).

French psychoanalyst Jacques Lacan noted that "the unconscious is structured like a language" and proposed the term "clinic of the signifier" (at the very foundation of the subject lies his encounter with the word (Lacan, 1995). It is appropriate to recall here that the subcortical sphere functions as a genetically determined sphere where purely human abilities (thinking, language, value concepts) do not manifest themselves. Jacques Lacan's thought can only be attributed to the peculiarities of the functioning of the mechanisms of the neocortex.

3. Methodology & Results

In the study of the concept of neuro-linguistics, characterizing the functions of 49 centers of the cerebral cortex, in particular, the Broca's center, the Wernicke zone, and the ventral pathway connecting the optical center with the center for semantic analysis, the stumbling block was the problem of detecting a single center in the cerebral cortex, consisting of the ancient (paleocortex), old (archicortex) and new (neocortex) hemispheres layers that coordinate the most complex processes of establishing, transforming and functioning a neural network that ensures the smooth operation of the mechanisms of language and thinking. One of the most popular concepts of cortical mechanisms is the idea of traveling waves of excitation of cortical neurons (Ritchhart, 2002).

It should be noted here that the search for an answer to this question has not been successful, because the cortex as a neoplasm does not have such a center, moreover, such a center cannot function fully in isolation from the nuclear structures of the brain, which play a dominant role in the formation and development

of consciousness, intelligence and language.

According to the researchers, the deep biomolecular codification system functioning in the substance of the brain is the result of the "fusion" of molecular information, chemical energy and organic matter into one structure (three-dimensional dimension—structure, matter, information). Coordination of the mechanisms of mental representation in the cortex is carried out by a deep system of information codification located in the subcortical sphere, unilaterally (without the participation of the cortex). The transformed neural substrates of the cortex retain the properties of the material and energy basis of information processing, however, these substrates, unlike subcortical ones, are in a latent state and their activity depends entirely on the receipt of energy impulses and genetic information from the subcortical layers of the brain.

When identifying the immanent properties of the information codification system in the neocortex and subcortical area, it is necessary to proceed from the nature of the formation of living beings in ontogenesis (gr. on (ontos) being + genos birth] biology, the totality of transformations an organism undergoes from birth to the end of life, the individual development of the organism, and phylogenesis (gr. phyle tribe, genus, species + genos birth, genus) in the process of historical development. The system of information codification in the subcortical sphere embodies the genetic potential that arose in phylogeny—in the centuries-old historical development, therefore, this system was endowed with new unique properties in the course of evolution, allowing it to control the mechanisms of the cortex. One of the properties of this system is the preservation of the body's viability to the conditions of existence. The neocortex as a neoplasm of the brain substance is the result of the individual development of the organism in ontogenesis, the advantage of which is the acquisition of new properties that contribute to the formation of a full-fledged person. The potential of ontogenesis creates the basic basis for acquiring human mental abilities for thinking, language, and human emotions, while phylogenesis preserves all the abilities for vital activity, establishment, and development of mental structures in the cerebral cortex, through which a person acquires reason, intelligence, and language. The brain is both a product of historical and individual development, at the same time, this substance is the biogenetic basis of human existence throughout life. In the process of creative activity, the potential of both phylognetic and ontogenetic development is actualized in the substance of the innovator's brain.

The connection between the cortex and the subcortical sphere is carried out due to the functioning of afferent and efferent pathways. Afferent pathways provide information about the state of the external or internal environment of the body to the corresponding departments of the nuclear structures of the brain. Efferent (motor, motor) neurons transmit an impulse from the nuclear structures of the brain to effector organs (muscles, vessels, glands). Their neurons are located in the cortex, the nuclear structures of the brain, and the anterior horns of the spinal cord.

The genetic support mechanisms forming the neural network of the subcortical sphere of the brain substance, based on instincts (mainly on the instinct of communication), play an important role in creative innovation, because creative abilities manifest themselves only in the presence of a close relationship between the neocortex and the subcortical sphere based on instincts. Eric Pianca, an American biologist, zoologist and evolutionary ecologist at the University of Texas, defined human instinct as follows: "Instinct is a genetically programmed behavior that increases our ability to cope with vital unforeseen environmental circumstances."

The American psychologist Abraham Maslow argued that people don't have instincts because they can overcome their desires. He argued that "instincts" are actually very strong motivations for a certain type of behavior. In his opinion, instincts were inherent in humans in the past, but were later replaced by consciousness (Maslow, 1954).

It is appropriate to note here that consciousness, intelligence and human qualities manifest themselves only in the neocortex (cerebral cortex), all genetically determined human properties, including instincts, are preserved in the subcortical sphere. Some scientists recognize the role of instinct in intelligent, including creative activity (Rodgers, 2020). In the creative process, the instinct of communication is of particular importance, the neural structures of which are located in the nuclear zone (in the reptilian brain, thalamus and hypothalamus).

Generative linguistics (transformational generative grammar, transformational generative grammar, Chomskian linguistics, generativism), the founder of which is Noam Chomsky (USA), considers the study of the hypothetical innate structure of language to be a matter of linguistics. It should be noted that such a structure functions in the neocortex, and the underlying base is located in the subcortical sphere. N. Chomsky's transformational generative grammar introduces two levels of syntactic representation: deep (deep, the so-called deep structure) and surface (surface, the so-called surface structure). He believes that the task of syntactic description is to calculate all deep and surface structures, as well as establish strict correspondence between them (Chomsky, 1972). The opinion of the American scientist about the need to establish a strict correspondence between deep and surface structures is deeply reasoned, however, all the mechanisms for implementing such calculations are associated with thinking and language, without taking into account the role of subcortical structures of the brain.

As stated by J. Lakoff, "We are neural creatures...Our brain receives information from the rest of our bodies. What our bodies are like and how they function in the world thus structures the very concepts that we can use to think. We can't think anything, just what our embodied brain allows". In the process of discovering and comprehending innovations, specific mechanisms of the neocortex play an important role—ventral (Latin ventralis—abdominal (anterior) and dorsal (dorsum Latin.—back) path. Ventral flow (the "What?" system) It ends in the inferior temporal cortex, which is closely related to the functioning of memory (including due to the presence of connections with the hippocampus and other areas of the cortex

associated with memory). According to clinical data, damage to the inferior temporal cortex leads to impaired recognition of visual objects. Dorsal flow (the "Where?" system) It is responsible for the perception of the spatial position of objects in the visual field, which is also confirmed by experimental data obtained during the artificial destruction of the parietal cortex (Ranganath et al., 2004).

The energy supply of the brain is provided by neurons (cells capable of generating and conducting electrical impulses) and astrocytes. Neurons generate action potentials, conduct excitation, and integrate information received from different receptors. Astrocytes create conditions for the normal activity of neurons (Peters et al., 2004). In the process of innovation, brain energy consumption increases dramatically, such an imbalance in energy supply is overcome by the joint work of neurons and astrocytes.

In the creative process, the sequence of processes of cognition and identification of innovation is important, the most important of which are the detection of a problem field, the representation of innovation, nomination and representation.

In the process of creative activity, a person must first discover the problematic field of innovation search. When analyzing the innovation field, many issues can be identified, among which the "core" problems stand out. Such postulates are a source of innovative ideas and enhance motivation for creative activity. Previously investigated and newly discovered problem fields are selected as the object of research. Both options for finding relevant issues require leaving the precedent range of knowledge that has been recognized in the scientific community and discovering unprecedented ideas.

In jurisprudence, the terms precedent are widely used (from Latin. praecedens "prior") is a case or event that took place in the past and serves as an example or basis for subsequent actions in the present, Non—case law (sometimes referred to as professorial law), Unprecedented law (emphasizes not only its distinctiveness, but also its uniqueness). In the process of innovative creativity, there are both precedent and unprecedented presumptions that follow each other in a strictly defined sequence: initially, the innovator must possess extensive knowledge of a precedent nature from various fields of science, then new non-precedent disordered hypotheses, ideas and concepts appear, most of which are discarded in the course of research, at the third stage the innovator has an unprecedented idea that differs from all precedent knowledge in its uniqueness., It reflects the innovator's new vision of the innovative problem being developed (the inventor has an idea of the model of the device, device, etc.). At the same time, the knowledge that is firmly entrenched in long-term memory, precedent knowledge, is the basic one for exploring the problem field of future innovation.

It should be noted that the field of storing and using precedent knowledge is the neocortex, where short-term, operational and long-term memory, mechanisms of consciousness, thinking and language function. Precedent knowledge is preserved in the neural structures of the cerebral cortex, and the subcortical sphere generates an innovative idea, the formation of which requires new expenditure of

nervous energy, the main source of which is the nuclear subcortical sphere of the brain (there is no autonomous energy supply system in the neocortex).

From our point of view, when highlighting the problem of the participation of neural structures of the cortex and subcortical sphere in the innovation process, it is necessary to rely on the conceptual provisions of neurobiology and genetics, first of all, the theory of cellular automata capable of self-reproduction, similar to a living cell, described in J. von Neumann's book "Theory of self-reproducing automata" (von Neumann, 1966). A follower of the scientific concept of the famous scientist L. Edleman calculated the optimal traveling salesman path by defining a seven-node instance of the Hamiltonian graph problem, an NP-complete problem.[Edleman, Leonard Max Eponym] Brain neurons, structured in phylogeny, Based on the concept of J. von Neumann proposed the term biocomputer (also biological computer, molecular computer)—a computer that functions as a living organism or contains biological components. The creation of biocomputers is based on the direction of molecular computing. Proteins and nucleic acids that react with each other are used as computational elements.

Fifth-generation computers in accordance with the ideology of computer technology development, after the fourth generation built on ultra-large integrated circuits, it was expected to create the next generation focused on distributed computing, at the same time it was believed that the fifth generation would become the basis for creating devices capable of imitating thinking.

A large-scale government program in Japan to develop the computer industry and artificial intelligence was undertaken in the 1980s. The program ended in failure, as it was not based on clear scientific methods, moreover, even its intermediate goals proved to be technologically unattainable. The occurrence of such problems is primarily explained by the inability to create an artificial device identical to a living cell in its inherent properties and functional characteristics. It should be assumed that solving this problem related to the paradoxes of wildlife will be a very difficult task for science and technology even in the foreseeable future.

Innovation in modern society is increasingly linked to the problem of improving artificial intelligence and creating external computer devices in the form of robotics. It can be assumed that in the foreseeable future, a robot carrier of artificial intelligence (artificial intelligence) may be created, as close as possible to the mental abilities of homo artificial humans. However, there is a high probability of paradoxes in establishing the correct relationship between homo sapiens and homo artificial.

The reflection of objective reality in the substance of the human brain and sensors (technical analogues of the sensory organs of living organisms) are not identical. Such differences are taken into account when developing a chatbot, a program running inside a messenger.

John Rogers Searle argued that consciousness is a real subjective experience caused by physical processes in the brain. He rejected the possibility of reproducing the semantic component of human intelligence by syntactic means (Searle,

1993). One can agree that consciousness is a real subjective experience caused by the biophysiological processes of the brain and concentrated in the neocortex, but one cannot ignore the nature of reproducibility of such an experience by various means, including syntactic constructions.

The theory of brain functioning focuses on the problems of artificial intelligence (Turing, 1950). A natural automaton (intelligence) as a way of processing information in the subcortical sphere in the form of DNA calculus has deep structures of the brain and functions in parallel with the system of processing sociocultural information in the neocortex. Man, being a natural automaton, surpasses in complexity any of the artificial automata created so far (Morin, 2019). And the theory of automata was supposed to connect the logical organization of complex automata with their behavior. From the point of view of physiology, the main difference between natural intelligence and artificial intelligence is that it has emotions that determine the motivation of its behavior (Nilsson, 1998).

Engineer Feng Guo from Indiana University in Bloomington and his team are currently working on the Brainoware project. It is a kind of bridge between artificial intelligence and biological tissues. It is an alloy of brain organoids connected to an array of high-density microelectrodes, where reservoir computing is involved. The work consists in transferring information by electrical stimulation to an organoid, then to a reservoir, where this information is processed even before Brainoware gives results in the form of neural activity. For the input and output levels, familiar computers are also used, where neural activity was read at the output layer, and later a classification was given based on the results of the input data.

Such studies indicate that science creates the prerequisites for the development of artifact devices that enable the functioning of a biocomputer powered by artificial intelligence, similar to the brain. Noting the prospects of such research, it should be noted that attempts to solve this problem currently create the prerequisites for the development of man-made devices in the foreseeable future that only partially actualize the unique properties of the brain.

There are many neurotransmitters and hormones in the human brain that cause various sensations—feelings of fear, joy, aggression and sleep, which are not present in artificial intelligence (von Neumann, 1966).

One of the mechanisms for triggering the creative creative process is the identical perception of intentions (creative inspiration, exaltation, emotional experiences, creative possibilities) that arise in the neocortex.

The innovator must first find an adequate name for the innovation that reflects the essence of the innovation. A vivid example of an inadequate understanding of the meaning of innovation is the story of the creation of an electronic lamp by Thomas Alva Edison, an American engineer. This invention actually marked the beginning of a new era in the development of civilization—the information age. The famous inventor has received 1093 patents in the USA and about 3000 in other countries of the world. The inventor introduced a new incandescent lamp with a service life of 1200 hours, which was patented and named an electronic

lamp. The inventor made the discovery without understanding the significance of this innovation, because he was not engaged in research on the problems of theoretical physics. Later, theoretical physicists gave an adequate name to this physical phenomenon—thermionic emission—the emission of electrons from a solid, metal, and semiconductors into free space when heated to a high temperature (Edison, 1884). After the invention of the electron lamp, new inventions were carried out, which actually marked the beginning of the era of electronics and information technology. Over the course of several decades, more advanced inventions have been proposed, which have become a necessary component of a unique electronic device—a computer. These inventions include the creation of a diode, a triode, a transistor, and a chip (microcircuit).

In creative activity at the nomination stage, the verbalization of a concept is of great importance (from Latin. conceptus—comprehension, concept), a structural and meaningful unit of consciousness reflecting a set of knowledge, ideas, opinions about the object of thought and conceptualization as the creation of an abstract model of some phenomenon in the world, expressed in verbal form. Concepts reflecting the essence of innovation are preserved in new cortical structures that are unilaterally established and activated by the subcortical sphere. In this case, sequential codification occurs first in the subcortical sphere in the form of DNA calculus, and then in the neocortex in the form of logical operations. The coordinated work in the two brain substances is coordinated in the nuclear structures due to the implementation of afferent connections established by the subcortical sphere in a dominant manner (a person understands the meaning of new concepts, has the ability to transform them, but he is deprived of the opportunity to directly consciously participate in the process of structuring and controlling the neural structures of the neocortex). The innovator, thanks to the intellectual potential accumulated in the neocortex, has the opportunity to rely on previously expressed similar judgments, assess the significance of his innovation, present the innovation for discussion by the scientific community, can identify the mechanisms of functioning, but he does not have the opportunity to interfere and change the natural paradigm of genetically determined processes for structuring neural formations of the cortex, which belongs to the prerogative of deep spheres the brain.

During the nomination process, the innovator suggests deeply reasoned names of the innovation. However, in the history of science, there are cases of proposing a sought-after term or the name of an innovation based on false arguments. For example, the term artery (from Greek ἀρτηρία)—aer "air", and terein "preserve", meaning a blood vessel carrying blood from the heart to organs, is attributed to Erasistratus, who believed that arteries serve to enter the body with air. In modern anatomy, an artery means a blood vessel that conducts blood from the heart to various organs of the body, but the erroneous name proposed by an ancient Greek physician is still used as a generally accepted term.

One of the unique mechanisms for identifying innovations is the process of de-

termining the frequency coefficient, which obeys Zipf's law, based on the American linguist George Zipf, an empirical pattern of the frequency distribution of words in a natural language: if all words (or just a sufficiently long text) are ordered in descending order of frequency of their use, then the frequency of the nth word in such a list will be approximately inversely proportional to its ordinal number n (the so-called rank of this word).

Zipf's law, as a specific phenomenon that occurs at the junction of consciousness and the unconscious, is of great importance for the full identification of innovation. A creative person thinks about an innovative idea and creates a model of innovation primarily in internal speech, while subconsciously choosing words that are essential to substantiate the initial concept (theory, hypothesis). The choice of the optimal option is subject to Zipf's law, which helps to select the core words and expressions and discard the secondary ones, concisely state the essence of the problem being developed. Mathematical formulas and symbolic designations are often used to compactly present innovative ideas, which also obey this law.

The processes related to Miller's law "The Magic Number seven plus or minus two", a pattern discovered by American psychologist George Armitage Miller, a member of the US National Academy of Sciences, are also of interest. The essence of this law is that short-term human memory cannot remember and repeat more than 7 ± 2 elements.

Speaking about the significance of this pattern in the creative process, first of all, it should be noted that in the process of developing an innovation, short-term memory mechanisms function, which make it possible to hold an image (concept) for 20 seconds. This short-term memory mechanism works until a new thought is fixed in the proper form. These memory mechanisms create the conditions for a smooth, logical transition from one innovative idea to another and the preservation of the final formulation of the idea in long-term memory.

The biophysiological codification of innovation in the deep substance of the brain depends on the extraction by the subcortical sphere of impulses of intentions arising in the cortex due to the influence of socio-cultural realities.

4. Conclusion

For further scientific identification of the neural mechanisms of the binary system of the brain substance, which provides creative innovative activity, it is necessary to bring the above judgments to a common denominator:

1) The process of neuro-linguistic identification of an innovation involves a genetically determined subcortical sphere as the generative basis for the identification of an innovation and a closely related brain neoplasm—the neocortex.

2) The interrelation of the neural mechanisms of the neocortex and the subcortical sphere in creative activity is ensured by afferent and efferent connections established by the deep sphere of the brain without direct conscious participation.

3) In the creative process, the innovative idea and theory are consistently codi-

fied, first in the subcortical sphere in the form of DNA calculus, and then in the neocortex at the level of mental constructs.

4) In the process of innovative creativity, precedent knowledge from various fields of science and practice is used, based on which the innovator gets an unprecedented idea reflecting the innovator's new vision of the innovative issues being developed. Then all the unprecedented ideas are transformed into precedent knowledge and stored in long-term memory, functioning thanks to the neural structures of the cerebral cortex.

5) The subcortical sphere generates an unprecedented neural structure of codification at the instinctual level in the form of DNA calculations, then coordinates the process of turning this idea into mental constructs and provides them with additional energy.

6) The identification of innovations in the neocortex is subject to the empirical pattern of word distribution according to Zipf's law, and the preservation of words in short-term memory is carried out in accordance with Miller's law, 7 ± 2 elements.

7) Innovative activity is carried out on the contact line of two phenomena—the genetically determined neural system of the subcortical sphere and the neocortex as a neoplasm. The biophysiological codification of innovation in the deep substance of the brain depends on the extraction by the subcortical sphere of impulses of intentions arising in the cortex due to the influence of socio-cultural realities.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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