Neurocode, its Connection with the Genetic Code and Prospects for New Information Technologies

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Abstract

Research Objectives:

- Analysis of matter codes of various levels, neurocode, as applied to the nervous system, and establishing their connection with the genetic code,

- Solution of some issues of scientific explanation of the role of information in managing the functions of human life and behavior,

- Consideration of the fundamental possibility of creating a strong artificial intelligence based on the genetic code.

A critical analysis of existing methods for decoding the neurocode is carried out and the direction of further research is determined. The fundamental importance of taking into account and using certain physical properties of the neural structure to explain the encoding and decoding of information in the functioning of the nervous system is shown.

A solution to the "Hard Problem of Consciousness" and mental causality is proposed, which allows for a theoretically correct explanation of the mechanism of the influence of subjective reality on bodily processes. Based on this, the ability of the Ego system of the brain and its neurodynamic structure to self-organization, self-regulation, self-determination is established.

From a physical standpoint, the spiral structure of the genetic code is considered and the presence of its own electromagnetic long-range fields and radiation is substantiated. They are also a necessary factor in maintaining the activity of the neurocode and the functioning of consciousness. An ideology for creating a strong artificial intelligence based on the processes of self-organization of some forms of the genetic code is proposed.

Keywords: *Neurocode; Information; Genetic Code; Self-Organization; Artificial Intelligence*

Introduction

The development of neuroscience poses new topical theoretical questions, the solution of which determines not only the successful solution of its urgent tasks, but also broad interdisciplinary problems. This concerns the interconnection, deepening cooperation between disciplines of physical, biological, technological and social profiles. One of these issues is the explanation of the neurocode, its connection with the genetic code, and along with this, a deeper understanding of the concept of code itself.

It should be noted that the concept of neurocode is also widely used in a different, figurative sense, namely, as a concept of informatics, in computer science, in relation to the field of programming, research and use of artificial neural networks, in the development of new artificial intelligence (AI) technologies. Although achievements in this area can be important for biological and social disciplines, including neuroscience, we are faced with a different problem.

In the proposed article, the concept of neurocode is considered only in relation to the functioning of the nervous system, its subsystems and elements. That is, within the framework of current research in modern neuroscience, including such a fundamental question as the determination of the functional capabilities of the neurocode by the genetic code. Neurocode produces acts of representation of external influences and internal changes that are significant for the organism in the structures of the nervous system, performs the functions of information control, regulation and management of various organs and processes, and ultimately - the implementation of mental activity and purposeful behavior of the organism. This direction is of fundamental importance for the development of strong AI, the so-called genomic AI, and requires a more thorough study of the genetic code.

Materials and Methods

The issues related to the section "Materials and methods" are presented and discussed in detail in the relevant sections of the text of the article.

Results, Discussion and Conclusion

About the concept of code and its types

Any code functional structure serves as a necessary factor of self-organization in complex systems. The nervous system arosed in multicellular animals more than 500 million years ago. Before that, in them and in unicellular organisms, self-organization processes were carried out by means of chemical codes, the most developed integral form of which is the genetic code. It is the basis of all earthly life and biological evolution, which created a neurocode capable of providing high speed of information processing, its clear address, energy efficiency. This gave rise to an effective level of control and self-organization of a complex living system, which is determined by the generation and transmission of nerve electrical impulses - a new language of information management. This language continues to improve in the course of biological evolution and social development.

Considering the historical process of the emergence and development of new forms of self-organization and communications, it is necessary to clarify their continuity, the dependence of higher forms on lower ones, and, accordingly, the various types of codes specific to them.

In the conditions of our earthly reality, along with various chemical codes and especially the genetic code, as an integral basis of earthly life, the following types can be clearly distinguished:

- Neurocodes (among which the cerebral neurodynamic codes of mental phenomena, including those inherent in animals, are of particular interest),
- Social codes (various languages and non-linguistic means of communication in humans, institutional code structures of organization and management, all sorts of socio-cultural means of communication and management),
- Technological codes (primarily digital and other means of communication and management created in the course of the development of AI and robotics).

Physical codes inherent in inorganic systems are also distinguished, implying their ability to self-organize. But this fundamental issue requires additional clarification.

A code in the physical sense is understood as a self-sustaining "minimal" structure of matter and energy determined by the laws of physics. We are talking about different levels of self-organization. In this case, the code of each level is a stable result of self-organization of the codes of the lower level. The roots of life originate in the world of inanimate matter. The micro level forms a common basis and generates "order" for living and inanimate matter. These principles are based on topological resonance and synchronization. Further, the fundamental importance of taking into account and using physical properties and patterns to explain the coding and decoding of information in the genome itself and in the functioning of the nervous system will be shown.

In connection with the role of physical codes and physical self-organization, the problem of geological self-organization of our planet under the influence of internal physical processes and impacts from space also deserves attention. The creation of the necessary climatic and other conditions for the emergence and preservation of life on Earth, and then man and society, depended on this.

For our purposes, as already mentioned, it is necessary to deeply consider the relationship between the genetic code and the neurocode from the angle of the subsequent development of social, and then technological codes. Particular attention should be paid to the latest achievements in the development of AI, which is becoming capable of performing the functions of natural intelligence, and then, apparently, will be able to significantly surpass it. This leads first to the emergence of various forms of hybrid intelligence in humans, and then to its qualitative transformation. This marks the transition from biological and social evolution to anthropotechnological evolution, changing human nature and social self-organization, and thus to a qualitatively new stage in the development of earthly civilization. It is now in a state of extreme aggravation of the global crisis, which threatens its very existence.

Problems of decoding the neurocode

Achievements in decoding the genetic code and the human genome, the creation and use of genetic engineering methods have opened up fundamentally new possibilities not only in solving problems in medicine and health care, but also in the field of information technology development. Largely due to the decoding of the genetic code, the problem of decoding the neurocode was updated and acquired increased importance - a strategic task of the same scale. As the leading representatives of neuroscience emphasize, it occupies a central place in it and has been the subject of research for almost a century, starting with the famous work of Adrian and Zotterman [1].

The thorny path of neurocode research is sufficiently covered in the specialized literature. From the very beginning, all proposed neurocode models relied on the generally accepted position that the fundamental element of the brain language is the action potential (spike) of a neuron. But an adequate interpretation of its properties was important. Real action potentials are continuous oscillatory processes, differing in period, amplitude and shape of the phase portrait. Meanwhile, previously proposed neurocode concepts considered action potentials as identical discrete events. This was their fundamental flaw.

These concepts are usually divided into two classes:

1. Encoding by the speed of spikes,
2. Encoding by their exact location on the time axis.

Both approaches in some cases describe individual encoding factors, but in general remain insufficient for a complete explanation of the neurocode, since they are not capable of displaying the complex, multidimensional structure of the signal as a whole.

Over the course of several decades, various attempts have been made to "improve" these concepts by finding some "average speed" of spike action or determining the temporal structure of their sequences. However, even this did not allow us to advance in understanding the actual methods of neural encoding of a huge amount of information contained in a signal in a minimal time interval.

After all, decoding the code involves establishing a correspondence between the patterns of signal parameters and the patterns of neuronal activity, as well as the reverse restoration of the signal content from observing the activity of neurons. Any signal from the external or internal environment is also an oscillatory energy process with a certain amplitude, frequency, and phase changing over time. Interpretation of a spike as a discrete, always identical phenomenon immediately reveals a discrepancy between the models of encoded signals and the real indicators of brain function (in terms of a very high information saturation of the signal, high speed, and energy efficiency of the process of its encoding).

A decisive turn was achieved by changing the paradigm itself in the study of the neurocode.

As already noted, it is not carried out by purely discrete, always identical spikes. Its action potential necessarily includes an analog (wave) component and in this form can serve as a discrete unit of the neurocode. It is not digital, but analog-digital and therefore is capable of adequately encoding very large volumes of information in the shortest periods of time [2].

This new concept is called a symphonic neural code by analogy with a musical code (in the form of musical notation). Here, each neuron action potential, as experts say, is a note of the brain's music, i.e. it has individual waveform characteristics (period, amplitude, phase portrait). These characteristics form a neuron activity pattern with a certain spatio-temporal organization, allowing it to fit into the general brain music with its melodies (frequency pattern), rhythms (phase pattern) and harmonies (simultaneous existence of different patterns). The new concept uses and, to a certain extent, combines the rational provisions of previous concepts. According to experts, it provides a physical and mathematical description of the neural coding process, which is capable of explaining the information, temporal and energy efficiency of the brain.

Along with all these fundamental results, there is another extremely important aspect in the problem of decoding the neurocode, which has been intensively developed in the last two decades. These are questions concerning the state of that specific, immediate addressee in the nervous system, where the signal representation is formed, its code organization. This refers to certain receptors and effectors, as well as the structures of the brain and spinal cord that are activated further. They have direct and inverse, horizontal and vertical complexes of connections in the brain, forming complex neural networks. It is this kind of activated networks that act as a neurodynamic system, which is a brain code of information transmitted by a signal. This complex integral formation can be called a neurodynamic equivalent of the information content of the signal.

Here we have what is called the inverse problem of code deciphering. It consists in determining and restoring the content of the signal from its brain neurodynamic carrier. About fifteen years ago, such an experiment was carried out: a person looks at a certain object, signals are non-invasively transferred from his brain to a computer, and an image of the image subjectively experienced by the person appears on its screen. This became possible on the basis of methods of visualizing brain processes using EEG, PET, fMRI, and then other, more effective methods (for example, optogenetic) and the development of new neurocomputer interfaces. This area of neuroscience began to develop rapidly and was called "BrainReading" [3].

As is known, over the past two decades it has achieved very significant results, which are of primary importance for neurology, neurolinguistics, psychiatry, many problems of medicine, pedagogy. At the same time, it has become an important resource for the development of new approaches in the development of information technologies.

Taking this into account, it makes sense to address some typical questions concerning the scientific explanation of the role of information in the management of human vital functions and behavior.

Some theoretical considerations on the functions of information processes in the nervous system

Information is the meaning for the organism of a certain physical effect formed in the course of evolution and ontogenesis. Such a stable connection between a physical factor and its vital meaning for the organism is called code dependence. Information must be embodied on a certain physical medium, which is its code structure. In other words, information always exists only in a certain code form. But, at the same time, it is invariant with respect to the physical properties of its medium. The same information can be coded in different ways.

There are two types of codes:

1. "Natural" (open), when the information is immediately understandable for a given system. For example, the usual meanings of words in the English language, for those who speak it well.

2. "Alien" (closed), requiring a decoding operation, which is often a difficult task. In this case, decoding is actually the translation of an "alien" code into a "natural" one, an incomprehensible one into one that is understandable for a given system. Otherwise, it will not be able to use the information to control its organs, processes, and actions.

The problem of neurocode is a task of this kind at the level of conscious human activity, when its goal, for example, is to treat mental and nervous system diseases. However, at the preconscious level of control and self-regulation of physiological processes in our body, neurocode usually acts as a "natural", open code. Those structures of the nervous system to which it is addressed, as a rule, immediately "understand" ("accept", "recognize") the meaning of the transmitted information and produce a corresponding functional response. This ability has been developed in the course of biological evolution over millions of years. It serves us well now, being disrupted only in pathological cases. This is an important subject of research in medicine and related areas of scientific knowledge.

That is why we strive to decipher the neurocode in detail. This leads to a deeper understanding of the patterns of functioning of the nervous system and allows us to purposefully solve important medical and other practical problems. Moreover, fundamentally new prospects for self-knowledge and self-transformation of man are opening up, as happened as a result of the revelation of the genetic code.

Here it is appropriate to return to some questions of the so-called "Hard Problem of Consciousness", the theoretical solution of which was proposed by one of the authors of this article on the pages of the journal [4].

We have two main questions:

1. How to explain the necessary connection between information in the form of a certain phenomenon of subjective reality (let's designate it as A), experienced by a given person in a given interval, and the brain's neurodynamic carrier of this information (let's designate it as X). Analysis shows that this connection is functional: A and X are phenomena of the same cause and are simultaneous and are in one-to-one correspondence. If there is A, then there is X, and vice versa, a change in one means an equal change in the other. This is the basis for the experimental determination of the brain code A, which is X.

2. How to explain the obvious ability of the phenomena of subjective reality to serve as the cause of bodily changes, if the former cannot be attributed with physical properties - mass, energy, spatial characteristics (due to the fact that these phenomena represent virtual reality, and not objective reality, which excludes their identification. Let us recall a striking example of Kant: five thalers in the mind is one thing, and in my pocket is another.

Both of these questions are resolved on the basis of the information approach, described in detail in the above article [4].

Considering conscious mental phenomena (subjective reality), we can distinguish two fundamental properties in them:

1.   Phenomenon A, say, the image of my interlocutor that I am currently experiencing, is information given to me in its "pure form". This means that its carrier is completely eliminated for me; I do not know or feel anything of what is happening in my brain. This is how we are made. In everyday life, to perform actions, we need information as such, and there is no need to know those complex, multi-faceted, multi-stage signal transformations in the brain that precede the emergence of an image and accompany it. Such simultaneous knowledge (attention) would not allow us to carry out fast, targeted actions and would disrupt acts of mental control.

True, as was said above, at the current stage of development of society with its technologies, man has learned to obtain such knowledge by deciphering the brain codes of mental phenomena. But this is still the lot of those few who possess such a technology and knows how to use it.

At the same time, however, along with great new practical opportunities, we also get great new problems. Previously, the subjective world of the individual was relatively closed, and she opened it to others, covered it from unwanted people, misinformed them, dosed her sincerity at her own discretion. Now, with the help of technology, it has become possible to open the secret inner world of a person against his will. Who and why will open us, but he himself will remain closed? A big problem!

2.   Along with the fact that we are given information in its "pure form", we have, however, the ability to operate it at will in a fairly wide range: to control our thoughts, switch attention, suppress questionable assessments, fantasize, change some of our beliefs and decisions, etc. As noted above, changing A means changing X. But this means (due to their simultaneity, unicausality and mutually unambiguous correspondence) that changing my thought at my own discretion means changing its brain code structure, i.e. a certain brain neurodynamic system. This is a fundamentally important conclusion. It shows that by voluntarily controlling my thought, I voluntarily control the corresponding brain processes, and that my Self, and therefore its brain neurodynamic structure, the Ego-system of the brain, have the ability of self-organization, self-regulation, self-determination. This ability has been studied by many representatives of neuroscience. Outstanding results of the development of this problematic, related to our Self, are presented in fundamental works [5,6].

A person is endowed with the ability to voluntarily control a certain class of his own brain neurodynamic systems. Each of us, without realizing it, constantly does this. Often not in the best way for ourselves.

Nevertheless, the presence of this ability clearly indicates the exceptionally large and still insufficiently used resources of purposeful self-organization of our life activity, the wide possibilities of mental control and self-regulation. After all, we know many facts when a person, straining his will and mind, managed to survive in extreme situations, in conditions that would seem to be clearly incompatible with life, to show an unshakable will to victory over enemies and over himself. These abilities also clarify the problem of mental causality, which is a type of information causality that allows us to theoretically correctly explain the mechanism of the influence of subjective reality on bodily processes.

The significant results achieved by neuroscience in the field of "Brain Reading" and in other areas of mental activity research constitute, as already noted, also an important resource for a new stage in the development of AI and anthropotechnological evolution, changes in human nature, and thus solutions to acute problems of overcoming the global crisis of world civilization (see more details [7]). In connection with such a strategically significant turn of scientific knowledge, the program for developing strong AI is also changing significantly, related to the need to turn to the genome as the primary source of our Mind.

The genetic code and the task of creating genomic AI

Further study of the genetic code and its physical properties is an important resource not only for a deeper study of the nervous system, but also for the creation of strong AI and the development of new ways to transform Nature, man and society.

The main doctrine of genetics is based on the fact that all genetic information is contained in the linear sequence of DNA nucleotides. But this idea cannot fundamentally accommodate all the complexity inherent in living systems: epigenetic phenomena, mental processes, the emergence of various branches of life, the long-range nature of correlations in organisms, etc.

DNA has a hierarchical spiral structure, which still remains outside the due attention of modern biology and physics. Meanwhile, there is sufficient evidence that this structure contains a significant portion of genetic information and is a source of a long-range electromagnetic field and radiation that control the assembly of bioelements into single functional systems of the body. It is also a necessary factor in maintaining the activity of the neurocode and the functioning of consciousness.

Thus, the DNA of neurons, due to its own long-range field and radiation, determines not only their local properties, but also the functions of their systemic associations and the behavior of the entire neuronal ensemble.

From a physical standpoint, the genome can be considered as a sequential oscillatory circuit with distributed parameters. It operates simultaneously as a source of a specific field and as a receiver and converter of signals from the external environment. Our ideas about the genome can change greatly if we consider it taking into account the codes of inorganic matter (at the level of interatomic and intermolecular interactions), which are necessarily involved in its formation and functioning and establish a correspondence between their frequency, topological and other characteristics.

Code fields can be purposefully subjected to multilateral experimental testing, including the one we propose (see [8] for more details).

The idea of the presence of a field and its own radiation in DNA is confirmed by the experimental work of well-known scientific teams, including Nobel laureate L. Montagnier [9] and many others. Indeed, direct measurement of genome fields in a living cell is a very difficult task. Theoretical calculations are also extremely complex. Therefore, experiments are often indirect and sometimes controversial. But their logic and the abundance of other evidence allow us to confidently speak not only about the existence of such fields, but also about their most important role in the storage and functioning of hereditary information.

The idea of the presence of stable spatial codes in self-organizing systems that generate a hierarchy of their own long-range fields will allow significant progress in the field of studying the functions of information management and decoding the brain's neurodynamic codes of mental phenomena. The nature of these fields does not go beyond the interactions known to physics.

When they talk about the Mind or Intelligence of the genome and its creative capabilities, they mean those well-known numerous information competencies that have been developed over hundreds of millions of years of biological evolution and are effective ways of managing extremely complex life processes. Take, for example, the functioning of the circulatory system with its 100,000 kilometers of vascular beds, which is able to adequately respond to constant changes in the external and internal environment of the body. But, of course, in the foreground are the nervous system and the brain, which form our mind, which studies all this and itself. But we must admit that our mind is nothing more than a student of the Genomic Mind. We leave aside the complex philosophical questions about the prospects of human cognition and self-transformation that arise in this regard. But there is no doubt that the need to strengthen and improve our minds remains a very important task for humanity. And we are not only talking about computational, cognitive, practical abilities. Here, the improvement of the value-semantic, moral, existential properties and aspirations of our minds should be in the foreground. The idea of developing strong AI based on genome research, the creation of the so-called Genomic AI (GAI), which has been discussed recently, is connected with these urgent needs.

We are now at the very beginning of understanding and searching for ways to implement this project, which some scientists are skeptical about. However, at the same time, the idea itself is supported by a growing number of specialists who are aware of the great complexity of such a task, but are convinced of the possibility and necessity of its implementation.

It is important to note that the idea of the GAI gradually grew out of known, but narrower border areas: the study of self-organization phenomena in living and non-living nature; the use of DNA and living tissue for calculations by analogy with semiconductor elements; the creation of artificial neural networks based on living cells; the use of DNA to obtain new materials; the use; creation of environments and technologies for the artificial evolution of DNA. Significant progress has already been achieved in these areas, many experimental works have been published, real technologies have been created. All this is directly related to the development of the GAI and supports confidence in the real possibility of solving the problem.

The question arises as to what form the creation of the GAI is supposed to take. Some adherents of the GAI idea are determined to achieve this goal by constructing a device on a non-biological substrate as a separate self-organizing system possessing the functions of the GAI. Such an intention, in our opinion, does not deserve support for two reasons. Firstly, the creation of such a system at the current scientific and technological level is highly unlikely. Despite the abstract theoretical conceivability of such a possibility due to the principles of isofunctionalism of systems and invariance of information in relation to the physical properties of its carrier, there are currently no real approaches or prospects for solving this problem. Secondly, even if they existed, then activities in this direction should be prohibited, because the creation of such an artificial intelligence system, superior to natural intelligence and possessing an uncontrolled autonomous program of activity, would pose a direct threat to human existence.

Another approach is acceptable, which consists of consistently clarifying and modeling the functions of the genome, combining them, humanizing them and then gradually implementing them into human consciousness.

The decoding of the genetic code led to the creation of genetic engineering, significantly expanded the capabilities of medicine. Decoding the neurocode leads to the development of neural and psychological engineering, which can contribute not only to the successful solution of problems in psychiatry and neurology, but also to fundamental tasks of improving mental activity.

GAI should serve to achieve a qualitatively new level of development of the human mind, its creative abilities, genuine existential meanings and goals of life. And this transformation should be considered not in the paradigm of transhumanism, but in the paradigm of the New High Humanism, in the perspective of the transition of world civilization to a qualitatively higher level of development.

There are many possible options for physical experiments in terms of establishing a connection between consciousness and the genetic code and neurocode. The authors proposed some schemes and algorithms for using genome functions as GAI agents based on known physical patterns and effects.

Use of AI Tools Declaration

The authors declare they have not used Artificial Intelligence (AI) tools in the creation of this article.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

All authors made equal contributions to the conceptualization, methodology, analysis, and writing of the manuscript. The final manuscript was approved by all authors.

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