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SYNERGETICS AS A NEW THEORY OF SELF-ORGANIZATION AND ITS BASIC POSITIONS – THE LEGACY OF HERMANN HAKEN. RESEARCH INTO THE PRINCIPLES OF BRAIN FUNCTIONING: BRAIN ACTIVITY, MOTOR BEHAVIOR, VISUAL PERCEPTION. THE END OF THE 20TH CENTURY. ARTICLE TWO

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In memory of Hermann Haken, the German scientist and the founder of synergetics as a science

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Actuality. New theoretical foundations of synergetics initiated by G. Haken and some conceptual models of psychosynergetics and alphalogy by I. Yershova-Babenko are presented. Research of the brain in synergetic, on the one hand, and the product of the combined activity of the brain and psyche – on the other.
The goal is to present the legacy of the initiator of synergetics, the German scientist G. Haken, and to show some steps in science of the late 20th century in Ukraine. To show the transition in philosophy, methodology, and science from a complex whole consisting of separate parts (in synernetics) to the relationships between complex wholes (in psychosynergetics and alphalogy).
Methodology and conceptual model. G. Haken's methodology of synergetics in brain research is based on the movement towards using a single parameter that arises and subordinates various activities to itself. And in psychosynergetics and alphalogy, the conceptual model of the "The whole-in-The whole" is based on the hyperintegrity/unity of the aggregate activity of the human brain and psyche and the emergence of the "product" as a subject.
Results. The theoretical concept of synergetics by G. Haken was created on the basis of self-organization (a new theory of self-organization). A psychosynergetic conceptual model, an alphalogical concept and a hypertheory were created, which express the combined activity of the brain and psyche as a nonlinear whole.
Key words: synergetics, new theory of self-organization, psychosynergetics, alphalogy, conceptual model (new philosophical category) "The whole-in-The whole/The whole in The whole", concept and hypertheory "b-p (m/c, ...)".

І. В. Єршова-Бабенко
СИНЕРГЕТИКА ЯК НОВА ТЕОРІЯ САМООРГАНІЗАЦІЇ ТА ЇЇ БАЗОВІ ПОЗИЦІЇ – СПАДЩИНА ГЕРМАНА ХАКЕНА. ДОСЛІДЖЕННЯ ПРИНЦИПІВ ФУНКЦІОНУВАННЯ МОЗКУ: МОЗКОВА АКТИВНІСТЬ, РУХОВА ПОВЕДІНКА, ЗОРОВЕ СПРИЙНЯТТЯ. КІНЕЦЬ ХХ СТ. СТАТТЯ ДРУГА
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Актуальність. Викладаються нові теоретичні основи синергетики, ініційованої Г. Хакеном, та деякі концептуальні моделі психосинергетики та альфалогії І. Єршової-Бабенко. Дослідження мозку у синергетиці, з одного боку, та продукту сукупної активності мозку та психіки – з іншого.
Мета – викласти спадщину ініціатора синергетики, німецького вченого Г. Хакена та показати деякі кроки в науці кінця ХХ ст в Україні. Показати перехід у філософії, методології та науці від складного цілого, яке складається з окремих частин (у синергетиці), до відносин між складними цілісностями (в психосинергетиці та альфалогії).

Методологія та концептуальна модель. Методологія синергетики Г. Хакена в дослідженні мозку базується на русі до використання одного параметра, який виникає та підпорядковує собі різні активності. А в психосинергетиці та альфалогії концептуальна модель «ціле-в-цілому» базується на гіперцілісності/єдності сукупної активності мозку та психіки людини і появи «продукту» як суб'єкта.
Результати. Створена теоретична концепція синергетики Г. Хакена на засадах саморганізації (нова теорія самоорганізації). Створена психосинергетична концептуальна модель, альфалогічний концепт та гіпертеорія, що виражають сукупну активність мозку та психіки як нелінійної цілісності.
Ключові слова: синергетика, нова теорія самоорганізації, психосинергетика, альфалогія, концептуальна модель (нова філософська категорія) «ціле-в-цілому/ціле в цілому», концепт і гіпертеорія «b-p (m/c, ...)».

Introduction

The second article is dedicated to the first anniversary and legacy of the German scientist Hermann Haken, who left us on August 14, 2024. It outlines the basic positions of Hermann Haken's synergistic approach to brain activity, motor behavior, cognitive activity, and visual perception. This is done for a clearer understanding of the connection between psychosynergetics and synergetics and their non-identity. He was an outstanding German scientist, well known in Ukraine and the post-Soviet space as the initiator of a new type of science, "synergetics", and of a synergistic approach to interdisciplinary research. A "new type of science" in this case refers to a science whose subject is represented simultaneously in different sciences. Herman Haken is the author of many books: *Synergetics* (1980), *Hierarchy of Forms of Instability in Nonequilibrium Structures* (1982), *Self-Organization and Information* (1983), *Principles of Brain Function. A Synergetic Approach to Brain Activity, Behavior, and Cognitive Activity* (1988), and others.

In modern science, there are both synergetics (G. Hacken) and psychosynergetics / alphalogy (I. Yershova-Babenko). On this basis, a conceptual model (a new philosophical category), "The whole-in-The whole/The whole in The whole" and its variants, which include integrity, complexity, the concept of "brain-psyche (mind / consciousness, ...)" – "bp (m/c, ...)", the hypertheory of the same name, have been developed [1; 2; 3; 4; 13; 14; 15]. All of them are related to the question of the relationship between wholes/integrity, that is, they demonstrate the proposed way out of the previous cognitive model "part – whole". In combination with the synergistic approach developed by Hermann Haken and our further steps – the creation of psychosynergetics and alphalogy, this provides a conceptual and methodological opportunity to consider a new object of research at the meta-level. We are talking about the product of the cumulative activity of the brain and psyche of a person during his life – "unaccounted product/subject" [3]. It is, in our opinion, the one that is actually actively operating in the lives of all people, both individually and in a group, social, and global plan. It is this product, and not just the brain or psyche separately, that a person uses throughout his life.

In synergetics, it is about the fundamental new knowledge of the second half of the twentieth century, about the study of general scientific (natural and socio-humanitarian, medical, technical) and philosophical problems of society and man within the framework of the new theory of self-organization. The author considers these issues using the example of such complex processes as the functioning of (1) the brain, (2) motor behavior, (3) cognitive activity, (4) visual perception, and (5) the cognitive process of man. When considering the brain, G. Haken emphasizes that *"the coordinated interaction of the "blocks" that form the brain is of decisive importance. An adequate analysis of these cooperative effects requires holistic and dynamic approaches that have a long tradition, in particular, in physics"* [9, p. 2].

As is well-known, the human brain is the most complex of the studied systems in nature. The author emphasizes that scientists often study its elements on an ever smaller scale, down to individual elements, but that coherence is also necessary. It serves, according to the author, "*for control of movement, for vision, hearing, etc.", giving the opportunity to "analyze emergent microscopic properties, for example, superconductivity, in terms of new concepts, and also to bridge the gap between microscopic and macroscopic phenomena*" [9, p. 3].

Based on this, the author concludes that thus, *"... experimental and theoretical research of the complex system called the brain requires the cooperation of many disciplines, including biology, medicine, physics, chemistry, mathematics, computer science, linguistics, and a number of others. Thus, brain research becomes a truly interdisciplinary endeavor"* [9, p. 1]. (IV: Let us pay attention to the current development of the next step – this is the transdisciplinary conceptualization of nonlinear research, which is being developed by Ukrainian scientists [6]).

As we can see, the human brain is classified as the most complex system and the most complex of known organs, so the fundamental problem, according to the German scientist, is what important questions we can ask about brain activity? And indeed, we have raised another important question in psychosynergetic and alphalogy as a fundamental problem, regarding the product of the joint activity of the human brain and its psyche during life – "unaccounted product/ subject"), expressed by the concept "b-p (m/c, …)" and the hypertheory of the same name [13; 14; 15].

In science, the most well-known method is the decomposition of a complex system into simpler

parts. In the movement of this method, the author writes that in the case of the brain *"using this method, we find individual parts of the brain, such as neurons and glial cells. Reducing these cells further, we find, for example, membranes, receptors, organelles, and at an even more fundamental level – biomolecule. Numerous chemical, electrical and electrochemical processes occur inside and between cell"* [9, p. 6–7].

However, it is here, according to G. Haken, that the mystery begins, which is that when controlling movements, recognizing patterns, or making decisions, *"myriads of neurons must act in a coordinated manner – in a highly regulated, orderly manner. The same question… in anthropomorphic terms: who or what controls the behavior of neurons? ... here we are faced with the secret problem of the mind-body proble)"* [9, p. 10–11].

The answer given to this question by the German scientist is based on synergetic – an interdisciplinary field of research, the beginning of which was laid by him in the early 70s. Since then, synergetic has found application in physics, chemistry, biology, computer and socio-humanitarian sciences, and medicine. On its basis, psychosynergetics were born – the application of the principles of synergetic to the study of the human psyche and its cognitive activity (1992) and sociosynergetics – the application of the principles of synergetic to the study of social systems.

General principles and concepts of synergetic, specific models of experimental results were formulated by the author from a single – synergistic point of view as a path to a deeper understanding of the mechanisms of brain activity.

First of all, the works of G. Haken deal with possible connections between the concepts of synergetics and human perception. In the work "Synergetics: An Introduction to the Synergetics Approach" (1974), the author interpreted the visual perception of ambiguous figures as the result of bistable states of order parameters in synergetic systems, that is, in self-organizing systems.

In the following work "Some Basic Ideas of Dynamic Information Theory" (1980), the scientist outlined the idea/concept that pattern recognition by humans or machines is a specific type of pattern formation, just like in self-organizing systems.

Further in the work "Advanced Synergetics: Hierarchies of Instabilities self-organized systems and devices" (1983), the author put forward a general proposal – to consider the human brain as a synergistic system that produces its macroscopic characteristic features through self-organization.

As a specific means of studying self-organization, Hermann Haken proposed considering qualitative changes on a macroscopic scale. This is shown in his works on the example of changes in gaits in horses, in which, on the one hand, behavioral patterns are clearly expressed, and on the other hand, no less clear transitions between these patterns.

Another position of the author is that *"the brain operates near instabilities, where only some modes of activity are detected again and again. According to the concepts of synergetics, these modes are controlled by order parameters that affect individual components, for example, neurons, according to the principle of subordination"* [9, p. 38–39].

In joint work with Kelso – experiments with finger movements (Kelso, 1983, 1984) [10; 11] it was shown that there are specific transitions between the two types of finger movements, which occur in a quite specific, but completely involuntary manner.

The model of finger movement in synergetic terms (Haken, Kelso, Bunz, 1985) [8] successfully demonstrates a number of experimentally detected modes. Together with the general results of synergetic, this model predicts some new modes. In the work "Stochastic theory of phase transitions in human hand movements" (1986), a group of authors described such modes as the hysteresis effect, critical fluctuations and critical deceleration. The mentioned model served as a starting point for the creation of more complex models of movement coordination. This is shown in the experiments described in the above works "Phase transitions and critical fluctuations in visual coordination of rhythmic movements between people" by Schmidt, Carello, Turvey (1990) [12], which are devoted to the study of the coordination of movements of different people. "Frequency Locking, Frequency Modulation, and Bifurcation in Dynamic Movement Systems" – Beck, Pepper, van Wieringen (1992) and others, devoted to research on finger tapping rhythm.

Thus, the central theme in G. Haken's synergetic becomes the phenomenon of coordination of actions of separate parts, which is described using order parameters and the principle of subordination of synergetic (IV: in contrast to this cognitive model – "separate parts and the whole", in psychosynergetic and alphalogy there is a model of "The whole-in-The whole/The whole in The whole", including nonlinear integrity [8; 13; 14]). This led the author to analyze the experiments in the work "Theoretical model of phase transitions in human hand movements" (1992), related to movement – Kerndtel. The experiments showed that *"during the learning process, a complex movement pattern is actually controlled by a single order parameter, which is subject to a simple standard linear equation"* [8, p. 351–352]. These movement patterns are qualified by the author as macroscopic indirect manifestations of brain activity (IV: we clarify that in psychosynergetics and alphalogy, "behavior patterns" are considered, including "motor behavior patterns", as well as manifestations of brain activity "at the movement level" within the framework of joint rehabilitation measures of traumatologists and psychologists in high-velocity brain injury with axonal disruption connections" [5]). The German scientist proposes to consider electric and magnetic fields created by the brain as other direct macroscopic manifestations of brain activity.

A more complex phenomenon in the studies of G. Haken was vision. In the work "Synergetic analysis

of human electroencephalograms: absence epilepsy (petit mal)" (1987) the author showed that his model of vision could be extended to the visual perception of ambiguous figures (described in "Fluctuations in the perception of ambiguous images: a model based on synergetics" Ditzinger, Haken, (1989)) [7]. This extended model allowed us to come into contact with a number of detailed experiments, and it itself became the basis for the description of stereoscopic vision.

The basis of the vision model was Haken's idea that image recognition is nothing more than their formation. This study of vision allowed the author to consider the mechanisms of cognitive activity. To prove the idea, he gives detailed analogies between types of decision-making. Such analogies are called, for example, a single, oscillatory or random decision. With their help, the author also explains the effects of hysteresis.

The next subject of G. Haken's research was brain networks. In their study, combined with the principles of brain functioning, the author relies on the idea of biological systems as complex.

As is known, most of these systems are written as consisting of a gigantic number of cells, each of which is also a complex system. (IV: in fact, in the language and from the standpoint of the conceptual model (new philosophical category, principle) "The whole-in-The whole/ The whole in The whole" this is equal to "complex in complex", and further to "behavior in behavior").

All these systems also have complex behavior, the author writes. One of the most striking features of living organisms, to which the German scientist draws attention, is the cooperative activity of numerous cells. The author emphasizes that it manifests itself, for example, in the coordination of muscles during locomotion or in other movements.

At the beginning of the 20th century, the famous physiologist Sherrington introduced the special term "muscle synergy" to denote the coordinated work of muscles.

G. Haken draws attention to the fact that such high coordination is demonstrated to us by the processes of breathing, heartbeat and blood circulation. Similarly, but at a higher level of organization, such coordination is observed in the work of the human brain, where a great many cells purposefully cooperate in their activities. The author emphasizes that it is precisely such cooperation that makes sensory perception, thinking, oral and written speech and other phenomena possible, including emotions.

The effect is particularly emphasized by the German scientist in all these cases at the macroscopic level, where, in his opinion, new qualities arise that are absent at the microscopic level of individual cells.

Separately, Haken considers the high level of interpretation inherent in the relationship between the microscopic and macroscopic levels and regards this as one of the greatest mysteries of biology.

In this regard, the author, when studying the brain, asks the question - how strong is the interpretative ability of our brain? And answers it with the help of an illustration - a painting by Giuseppe Arcimboldo (Fig. 1). Based on the book by G. Haken "Principles of Brain Function. A Synergetic Approach to Brain Activity, Behavior, and Cognitive Activity" (1988).

Fig. 1. Drawing by Giuseppe Archimbold (Based on the book by G. Haken (1988)).

At first glance, this painting appears to be a human face. However, upon closer inspection, a composition of vegetables and fruits becomes visible.

The author emphasizes, drawing a conclusion, that the process of recognizing a human face in a picture does not occur by individual details, but by bypassing them, that is, attention is not delayed on them. It fixes the picture as a whole in the person's memory (brain).

G. Haken suggests using this example metaphorically, that is, when the individual details are not fruits, but nerve cells. The author also asks the question, how does interpretation arise?

G. Haken emphasizes that his opinion is fundamentally different from the position of famous authors – neurophysiologist Eccles, who wrote in the 20th century, together with the philosopher Popper, the book "I and my Brain" ("Self and Its Brain"). The position of these authors is to present the "I" as a programmer, and his Brain as a computer.

In contrast to this view, Haken develops the idea of self-organization, i.e. instead of the assumption of Eccles and Popper that interpretation is determined by programmers or computer programs of one kind or another.

Thus, in fact, synergetics can be considered the most developed theory of self-organization, and Haken's work as a source for considering this theory in relation to a wide range of complex phenomena. Such phenomena are found in biological systems, in particular, those associated with various types of brain activity, motor behavior and cognitive activity.

Despite the fact that Haken considers the biological system as a gigantic system that functions according to the laws of physics, the laws of biology themselves, as emphasized in his works, cannot be unambiguously deduced from the laws of physics. The author emphasizes that there are also other, additional laws associated with the emergence of new qualities. That is why *synergetics does not conflict with physics*, on the one hand, and on the other, *synergetics should not be identified with any kind of physicalism.* **Synergetics is a discipline, self-organization is a phenomenon.**

Thus, as we see, the goals of Hermann Haken's synergetics are complex systems. They are interpreted by the author as those that *"consist of a large number of individual parts, elements or subsystems, which often interact in a complex way with each other"* [9, p. 3] (IV: as we see, the basis of Haken's idea of complex systems is "individual parts, elements or subsystems").

Descartes once proposed breaking down a complex system into smaller and smaller parts until a level is reached where those parts, or parts, become comprehensible. This is the approach followed by molecular biology.

On the other hand, as G. Haken emphasizes, the interaction of system elements leads to the emergence of qualitatively new properties and features at the macroscopic level. Therefore, the goal of synergetics is also to bridge this gap.

The author's works show that in most cases structures are created not by some organizing hand, but by the systems themselves, operating without any external influence. That is why we are talking about self-organization.

And within the framework of the approach, which can be called Cartesian, there is another problem, according to the author. To describe individual elements, a huge amount of information is required, which no one is able to process. This forces us to create adequate ways of compressing information.

The question arises - is it possible to develop a general theory that will allow for adequate information compression absolutely automatically? As shown in the works of G. Haken, such adequate information compression occurs in cases where the system qualitatively changes its macroscopic state. In the inorganic world, such abrupt changes are called phase transitions. (IV: note that in the group of the above positions, the cognitive model "part is whole" is the initial one). Examples: freezing, when water (liquid) turns into a solid state (ice), the emergence of a magnetized state or the onset of superconductivity. Similar qualitative changes, albeit at a much higher level of complexity, are abundant in biology.

So, the brain is a complex system in Haken's sense, but one that consists of "separate parts, elements, or subsystems".

As is known, the human brain consists of approximately 100 billion (10^{11}) neurons, and one neuron can have up to 10^4 connections. In addition, each neuron is considered in itself as a complex system, made up of separate parts, elements or subsystems. Neurons, according to experts, are interconnected in an extremely complex way. The number of neurons is incredibly large: *"Therefore,* – writes Haken, – *it is obvious that the number of facets of the study of the brain, behavior and cognitive activity can be incredibly large. However, success depends on the level of scientific research, which in turn depends on the experimental technique and theoretical concepts, as well as on the mathematical procedures used",* which is determined by tastes, fashion, our training*, etc. "Because of the tremendous complexity of the brain, we are forced to search for models, paradigms or metaphors"* [9, p. 8] (IV: we add that modern studies show a significant role of glia, which occupy a large % in the brain).

So, let's compare what traditional and synergistic interpretations of brain function exist?

First, we note that the reasoning based on synergetic positions differs significantly from traditional approaches. This is evident from Table 1. (Based on the book by G. Haken (1999)). In the left column of Table 1, the author lists traditional concepts, and the corresponding synergetic concepts are given in the right column.

Table 1

Comparison of traditional and synergistic interpretations of brain functions

Traditional concepts	Synergistic concepts
1. Single cell	1. Cell network
2. Separate element	2. Ensemble of elements
3. The cell that identifies our grandmother	3. A collection of cells that identify our grandmother
4. Leading cell	4. Team of leading cells
5. Actions are localized	5. Actions are localized
6. Engram	6. Distributed information
7. Programmed computer	7. Self-organization
8. Algorithm	8. Self-organization
9. Sequential information processing	9. Parallel and sequential information processing
10. Action is determined by deterministic events	10. Action is determined by deterministic and random events
11. Stable operation	11. Functioning near loss of stability

As we can see, traditional experimental and theoretical studies of the brain focus on a single cell. In synergetic studies, the focus is on the activity of an entire network of cells. Thus, instead of studying a single element – a single cell, synergetic studies the network/ensemble of brain cells.

The author illustrates the difference in synergistic research approaches with an example called "our grandmother's cell". According to theories from an earlier period of scientific development, we recognize our grandmother with the help of a special cell in our brain that identifies our ancestor. In contrast, in the synergistic approach, pattern recognition is achieved through the action of a network/ensemble of brain cells.

Similarly, some approaches argue that movement control is carried out by a single master cell, while the

synergistic approach argues that movement control is the result of the action of a network/ensemble of brain cells.

Thus, we see that some approaches consider brain processes/actions as strictly localized within a single cell, while in the synergistic approach they become delocalized and in relation to the brain they can be distributed over large areas of it. Therefore, following the synergistic approach, we should look not for engrams, but for distributed information. (IV: Similar views are shared, in particular, by supporters of connectionism – one of the approaches in the field of artificial intelligence, cognitive science, neurobiology, psychology and philosophy of consciousness. Within the framework of this direction, mental or behavioral phenomena are modeled by the processes of formation in networks of interconnected simple elements).

Thus, the main difference between the synergetic view and the views of some other scientific schools can be formulated as follows: the latter believe that the brain operates with the help of algorithms like a programmed computer; Haken believes that the brain operates through self-organization, which may or may not use a network, including algorithms.

Approaches of the "pre-synergetic" period of scientific development: it is believed that information entering the brain is processed sequentially. In the new, synergistic approach, it is believed that incoming information is processed mainly in parallel.

The traditional view of the brain as a programmed computer implies that the entire brain system operates deterministically. In contrast, within Hermann Haken's synergetics, the actions of biological systems are determined by both deterministic and random events.

Another fundamental difference between Hermann Haken's synergetic approach and the "pre-synergetic" views in science is manifested in the state of stability. These approaches proceed from the assumption that the brain is in a steady state. Numerous experiments on the study of brain function are based on this assumption. Hermann Haken offers the opposite point of view, experimentally confirming that the brain functions near points of loss of stability.

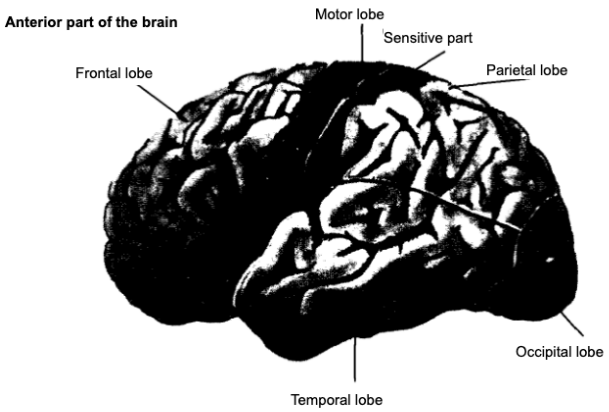

Fig. 2. Human brain. Left view.
(Based on the book by Haken (1999))

When studying the synergism of brain structure and function at the macroscopic level, it is revealed that different specific functions can be associated with certain areas of the brain. (IV: However, it should be noted from the outset that, as studies show, functions can migrate from one area of the brain to another, as a result of which the functional map of the brain can be transformed, for example, when the brain has been damaged and the damaged area is being repaired.)

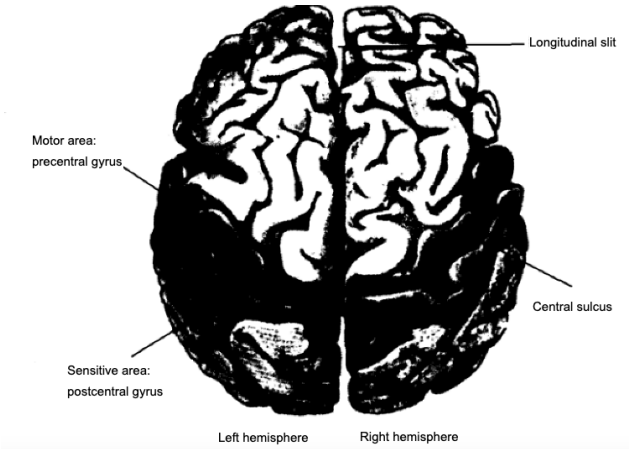

Fig. 3. Human brain. Top view
(Based on the book by Haken (1999))

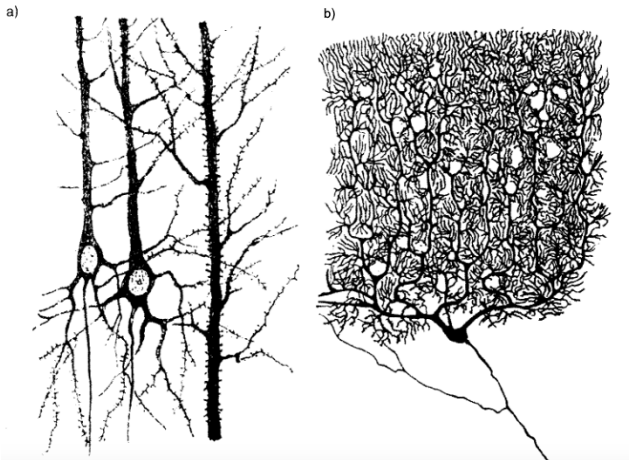

Fig. 4. (a) Pyramidal cells; (b) Purkinje cell
(Bullock et al. 1977).
(Adapted from Haken (1999))

In brain research, Haken also draws attention to the following methods: EEG (electroencephalogram), MEG (magnetoencephalogram), MRI (magnetic resonance imaging). For example, by analyzing the structure of some EEGs, the author established their correspondence to certain chaotic processes.

Another example in which the author draws attention to the fact that the information obtained in MEG experiments differs from the information obtained in EEG experiments, despite the fact that both signals have the same source – the electrical activity of neurons. Based on these results, Haken includes the following as significant differences between EEG and MEG. EEG records the difference in electrical poten-

tials between a certain point on the skull and a reference point. The electrical potential does not have a fixed value at this point in space at a certain moment in time, but the difference in potentials between two points in space is uniquely determined.

This problem has been widely discussed in the EEG literature, but there is still no generally accepted standard. It is assumed that the quantity measured by SQUIDs is the tangential component of the magnetic field, i.e., a physical quantity uniquely defined at that point in space at any time. Therefore, in the case of MEG, the experimental results are free from artifacts that arise from different choices of reference electrodes, as in EEG.

The second important difference between EEG and signals recorded by SQUIDs, which G. Haken draws attention to, is that EEGs are subject to volumetric distortions of conductivity introduced by the skull and tissues separating the electrode and the source of electrical activity. In the case of SQUIDs, there are no such distortions: the skull and tissues are transparent to magnetic fields distorted by electrical currents in the brain (IV: Little was known about the origin of these currents at the cellular or intercellular levels in the mid-1990s).

G. Haken also considers positron emission tomography (PET), which studies the increase in glucose concentration in active parts of the brain, the increase in glucose metabolism. The author draws attention to the fact that cells belonging to different areas of the brain, for example, areas responsible for processing auditory or visual signals, use the same code (pulse-code modulation, which is used in the transmission of nerve impulses. The higher the level of activation or the larger the postsynaptic potential, the faster the impulses are emitted).

Based on published research, Haken considers the issue of brain modeling, concluding that brain activity and behavioral patterns must be expressed in terms of different concepts. His main idea is to consider the brain as a synergistic system. At the heart of this idea of G. Haken is the idea that as a result of the cooperation of individual parts, new qualities arise as a result of self-organization. To explain the new synergistic approach, the author uses the basic principles of synergetic. (IV: In psychosynergetic and alphalogy, the brain is primarily considered as an initial integrity that is constantly changing, and then we are talking about interaction with other integrity / wholes, that is, about the relationship between integrity / wholes within the conceptual model (new philosophical category) “The whole-in-The whole/The whole in The whole”, which also includes nonlinear integrity [2; 3]).

To this end, H. Haken considers complex systems that occur in a number of disciplines, such as physics, chemistry, biology and medicine, as well as economics and ecology. He emphasizes that in all cases the systems consist of many components, subsystems, elements or parts. He also draws attention to the fact that some of the first steps of his analysis are very similar to the analogous operations of dynamical systems theory, but later crucial differences emerge between the two approaches.

Haken’s conclusion: the answer to the question of whether or not one can speak of random events depends on the chosen level of description.

Random events, from the author’s point of view, also occur in the human brain. For example, spontaneous opening of bubbles in neurons, random excitation of neurons or the occurrence of tremor. However, Haken’s conclusion regarding the answer to the question posed for microscopic processes in the brain does not clarify everything to the end: *“it remains unclear whether fluctuations in the brain have a fundamental, quantum mechanical nature or depend only on our level of description”* [9, p. 31].

Thus, the main idea of G. Haken’s synergetics in the study of complex systems is the search for qualitative changes in macroscopic scales of configurations, which are called “order parameters”. They describe the macroscopic order, or, speaking in general terms, the macroscopic structure of the system. The state of the system can be described as a superposition of all, that is, increasing and decreasing configurations. If the number of components of the system is large, then the multitude of individual configurations is also large. This means that the information necessary to describe the behavior of the system is not reduced to the decomposition of its configuration: this is where the central theorem of synergetics appears on the scene.

The central theorem of synergetics by H. Haken states that not only the behavior of increasing configurations, but also the behavior of decaying configurations is uniquely determined by the order parameters. As a result, the overall spatiotemporal evolution of the state q satisfies the order parameters (or obeys the order parameters). This is the principle of subordination.

Since in the general case the number of order parameters is much smaller than the number of system components, the principle of subordination allows to achieve a sharp reduction in the number of degrees of freedom, or, in other words, a strong compression of information occurs. In a certain sense, the order parameters act like puppeteers who make puppets dance. But in the understanding of what is actually happening, on the one hand, and in the naive metaphor with a puppet theater, on the other hand, there is an important difference. It turns out that by their collective action, the individual components of the system, or “puppets”, themselves affect the order parameters, that is, the “puppeteers”. On the one hand, the “puppeteers” (order parameters) determine the movement of the system components, on the other hand, the components, in turn, determine the action of the order parameters. This phenomenon is called circular causality.

G. Haken, considering in his works the question of the central role of order parameters, singles out a class of systems that have the following property: when one order parameter or, possibly, several order parameters change, the system becomes unstable! In other words,

the system leaves its previous state and begins to form a qualitatively new macroscopic state. And here, in the vicinity of the point of loss of stability, collective changes of various states appear; some of them grow, others, after their emergence under the influence of fluctuations, fade away.

The study of growing and decaying states enabled Haken to distinguish between unstable and stable configurations and, as a result, to arrive at configurations governed by order parameters. Order parameters determine the behavior of the components of a system through the principle of subordination. Thus, the behavior of complex systems according to Haken can be described and understood in terms of order parameters. At the same time, it is no longer necessary to consider events or the behavior of individual parts, since it is possible to describe the entire system in terms of order parameters.

Thus, the principle of subordination underlying the above-described relationship led H. Haken to a colossal compression of information, which he used as a means of studying the brain, behavior, and cognitive activity. In a huge number of cases, the number of order parameters is very small, and the behavior of the system can be considered in terms of these order parameters.

The author emphasizes that when studying the brain, we are dealing with myriads of neurons, but the number of patterns in behavior (however numerous they are!) is much smaller. Of course, order parameters are abstract quantities, but in many cases they find their concrete meaning.

With his research in mind, G. Haken formulates the following caveat. Since the principles of synergetics are illustrated by examples from physics (namely: the physics of liquids and lasers), someone may unreasonably conclude that synergetics is a kind of physicalism. However, such a conclusion is completely incorrect, because in synergetics the author proceeds from abstract mathematical relations, which he then applies to many systems of various natures, including physical ones. But since physical systems are relatively simple in comparison with biological systems, they are best suited as an example to illustrate the meaning of the mathematical principles of synergetics.

Haken's main idea is to consider the brain as a synergistic system. The basis of this idea is the idea that as a result of the cooperation of individual parts, new qualities arise as a result of self-organization. By self-organization of a system, the author understands that in the general case, when the activity of some external or internal control parameters changes, there are certain situations when the system undergoes not small, but significant changes in its macroscopic state. An example is the spontaneous formation of structures in lasers and liquids.

In biology and medicine, there are many such qualitative changes: from the formation of spatial structures or morphogenesis to significant changes in behavior, for example, in psychosis.

It is important to note that the control parameters do not allow for the prediction of the emergence of macroscopic structures and patterns. For example, a liquid heated from below is completely homogeneous; however, the interaction between the liquid molecules generates different structures that appear "suddenly and on the entire surface simultaneously".

The spontaneous formation of structures as a result of self-organization seems to contradict the second law of thermodynamics. According to the second law, in so-called closed systems, macroscopic order should disappear, giving way to a homogeneous state that, at the microscopic level, exhibits the structure of chaotic motion. For example, the motions of atoms in a gas are completely chaotic, but at the macroscopic level the gas appears to be practically homogeneous. This tendency towards the most chaotic and structureless state at the macroscopic level is formulated in the statement that the entropy of the system increases to its maximum value. However, this statement is valid only for closed systems that do not exchange energy or matter with the environment. At one time, the famous biologist Ludwig von Bertalanffy drew attention to the fact that biological systems belong to open systems, the structure and function of which are supported by the influx of energy and matter, either in the form of sunlight and substances extracted from the soil, as is the case with plants, or in the form of nutrients and oxygen, as is the case with animals. To denote this state of living matter, von Bertalanffy proposed the term Fliessgleichgewicht (current equilibrium).

All systems studied in G. Haken's synergetic theory can be considered as open and thus as satisfying the necessary condition of self-organization.

In synergy Hacken argues that near the points of loss of stability, the behavior of complex systems is governed by a small number of variables, namely: order parameters. In some cases, the number of order parameters is very small, and then researchers start by considering only one order parameter.

G. Haken writes that a mechanical model has proven to be very useful for describing the behavior of a single order parameter above and below the point of loss of stability of the system.

The conceptual field of G. Haken's synergetics includes the concepts of "bistability", "symmetry breaking", "symmetry-breaking instability", "critical deceleration", "non-equilibrium phase transitions", "bifurcation".

Summarizing all of the above on the example of considering G. Haken's views on the principles of the human brain within the framework of synergetics initiated by him, we draw a conclusion, emphasizing the differences of psychosynergetics as the next step in the development of scientific knowledge in understanding the complexity and behavior of open, self-organizing systems. Further consideration of these issues in research will be presented in the next article.

Table 2

Example of some views on the brain in G. Haken's synergetic and I. Yershova-Babenko's psychosynergetic and alphalogy

In synergy	In psychosynergetics and alphalogy
1. Cognitive model – "individual parts" and the whole	1. In psychosynergetic and alphalogy there is a "The whole-in-The whole/The whole in The whole" model, including nonlinear integrity
2. During the learning process, a complex movement pattern is actually governed by a single order parameter that obeys a simple standard linear equation	2. "Behavioral patterns" are considered, including "motor behavior patterns" as well as manifestations of brain activity "at the motor level"
3. Complex systems consist of a large number of individual parts, elements or subsystems that often interact with each other in complex ways.	3. First of all, the brain is considered as an initial integrity that is constantly changing and interacting with other integrity /whole, that is, we are talking about the relationship between integrity /whole within the conceptual model (new philosophical category) of "The whole-in-The whole/The whole in The whole", which includes nonlinear integrity. Through the concept of "b-p (m/s, …)" and the hypertheory of the same name, the total activity of the brain and psyche is considered, including its "product".

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