

The Concept of Dominance by A.A. Ukhtomsky and Anticipation

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*There is no such force, even within “positive science,” that
could free man from the burden of moral freedom.*

Alexei A. Ukhtomsky

Abstract This paper investigates the dominance theory articulated by A.A. Ukhtomsky (1875–1942). This theory is one of the earliest attempts to scientifically study the relationships of life and mind, and human behavior in particular. Ukhtomsky anteceded some ideas of cybernetics and synergetics, as shown in our previous works. On the other hand, one of the main problems analyzed by Ukhtomsky is the capacity of anticipation evident in the behavior of living beings. This work is devoted to the problem of anticipation from the viewpoint of the dominance concept.

Keywords Ukhtomsky · Anticipation · Behavior simulation · Dominance theory

1 Introduction. Religious and Philosophical Basis of Ukhtomsky’s Theory

Setting out to write this article, the authors are not sufficiently aware to what extent the name and legacy of Alexei A. Ukhtomsky (1875–1942) are known beyond Russia. In Russia, the popularity of Ukhtomsky during the post-Soviet period grew greatly due to the publication of his previously unavailable materials—letters and diaries that could not be published before due to the censorship of Soviet government [1–4]. Ukhtomsky is now popular among psychologists for having successfully formulated the principle of dominance as a common principle that allows for explaining many psychological phenomena from a unitary perspective [5]. He also became an idol of the Orthodox community as a successful Christian scientist—this

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also due to his brother, a bishop, prisoner and martyr of Stalin's concentration camps. Still, we consider that Ukhtomsky is not entirely understood in Russia, as various groups of supporters and critics each see Ukhtomsky in their own way. However, Ukhtomsky is interesting and powerful precisely because of his holistic aim: to create a comprehensive and complete theory about the behavior of living beings. "Science is in principle a cohesive world view.... Thus it's an offense against the basic principle of science when one tries to understand life from only one point of view. This is the sin of modern physiology, modern biology, and the sin of materialism of all times" [2, p. 83]. Ukhtomsky was a highly-educated man with advanced degrees in both religious-philosophical and natural scientific studies, in addition to excellent engineering-mathematical education. In his views on the role and place of science in the dynamics of culture on the whole, Ukhtomsky was strongly influenced by Russian religious philosophers—the Slavophiles A.S. Homyakov and U.F. Samarin, and later—the great V.S. Solovyov. We should note several important moments here. First, notwithstanding all the variety of its schools and theories, in Western philosophy there has been and continues to prevail a conception of the laws of nature as something absolutely constant and immutable, and of man—as the neutral and objective observer of nature, as someone who tries to discern the laws behind natural phenomena. The Russian school of philosophy questioned not only the absolute objectiveness of the human observer, but also the absolute constancy of the observed external environment, existing as if independent of time. It doubted the very concept of "externality" itself as the absolute separation of the observer from the observed. In other words, the Slavophiles did not consider the process of scientific creation to be absolutely objective, instead considering the subjective component to have significant influence—this particularly in the setting of goals and application of results. And where there is place for the subjective, ethical appraisal becomes possible. It is thus that Homyakov and Samarin could say—one can really come to know only what one loves. This implies a process of "getting in tune with," adjusting oneself to the object of cognition (Ukhtomsky can be considered as their follower namely in this sense). To what extent could this gnoseology be accepted by objective and practical science? Naturally, this did not happen without struggle—there were various objections, it was often not treated seriously. In 18th–19th century Russia, as well as everywhere else, scientific approaches were opposed to religious ones, and their disputes were rather offensive. Nevertheless the seeds were planted, and in one way or another they gave results—sometimes in unexpected ways. All the more so as the 20th century provided strong scientific evidence that observation cannot be neutral; it always entails the interaction of the observer and the observed, in the course of which neither can remain unaltered. Furthermore, based on new knowledge, human activity had led to significant and often irreversible changes in the objects that it studied, and this became obvious to everyone (e.g., extinction of some animal and plant species). It became clear that we do not live in a static environment, but in irreversible time, in a historical process. Not only did representatives of the humanities start to talk about irreversibility, ethics, and historical responsibility, but also leaders of the natural and exact sciences—highly successful scholars in some fields of knowledge, such as the chemist and Nobel laureate Prigogine [6] and

Prigogine [7] (a European of Russian origins). Some thoughts of Prigogine are in close agreement with Ukhtomsky's views. Let us compare two quotes. "We are not observers, but participants of existence. Our life is labor," [8, p. 149]; "The world is a construct, and we can all take part in building it," [7]. Prigogine reminded the whole world about the forgotten medieval understanding of law as necessity, not only as applied to the moral and legal law, but also the laws of nature understood as the behest of God—they may one day be altered or cancelled, but until then, living and inanimate nature must obey them (e.g., consider the famous tale of the chicken publically executed for not obeying the law and laying eggs).

Russian thinkers Homyakov [9] and Solovyov [10] fearlessly introduced concepts of Christian love and human personality as philosophical terms for scientific consideration. Ukhtomsky set himself the task of integrating these concepts in the natural sciences, particularly in the physiology of higher nervous activity, in creating the dominance concept. In Russian, the word "concept" differs somewhat from the word "theory" through the breadth of material it covers from a cohesive position—and in the current case this extent is in fact staggering. At the same time, some of the details of a concept can remain incompletely investigated, stay in the form of hypotheses and require further specification or rejection. Ukhtomsky's concept is in this sense a challenge to all of us, and although it is almost a century old, it remains a challenge that is still largely unmet. Ukhtomsky studied brain activity to the extent possible with the physiological methods available at the time, all the while giving a psychological interpretation to almost all his observations. In perspective, he set the goal of describing the mechanisms of behavior with a degree of accuracy that would enable the use of mathematical methods in their study. At the same time he had in mind the complete pattern of behavior, the people's relations with each other and man's relation with the world, based on Christian ethics. All of this should be considered while analyzing anticipation as understood by Ukhtomsky. From his point of view, activity is always directed towards some kind of future goals, and its success depends on the extent to which reality has been understood, based on the whole of past experience, the whole developmental history of the person, and the biological inheritance history of the species. This adequacy and depth of understanding are, in turn, determined by our ability to constantly renounce our own prejudice and egoism, to look at reality as it is with empathy and attentiveness. This is especially important in the social sphere, and particularly in interpersonal relationships where the reality we encounter is the personality of another individual. In dominants facing another person lies the leitmotiv and pathos of Ukhtomsky's concept.

2 Dominance—Common Definition. Dominants in Physiology

The initial definition of dominance was developed by Ukhtomsky based on physiological material. At the time when dominance theory was being created—the decades before and after 1920—the main research directions of physiology were

based on brain mapping (studying the correspondence between brain areas and peripheral effects) and reflexes (studying the correspondence between external stimuli and bodily reactions). Both of these directions were actively developed by Russian physiologists: it is sufficient to mention the Nobel laureate I.P. Pavlov in this regard. However, the scientific school to which Ukhtomsky belonged—the Sechenov-Wedensky School—investigated also more complex phenomena, where stimulus-reaction relations could not be seen as constants. The discovery of parabiosis by Wedensky marks one such phenomenon—an instance where nervous tissue reacts to the same stimulus with either excitation or inhibition depending on the phase of the underlying physiological process [8, p. 92]. Ukhtomsky was interested in the possibility of using the model of parabiosis in explaining functional coordination in the central nervous system. Discovery of the final common pathway as a physiological principle by the English physiologist Sherrington (“Sherrington’s funnel”) had raised a question: considering the vast number of sensory and other nerve centers active at the same time, how are some of them selected to control motor neurons and bodily movement? Sherrington himself offered the easiest explanation at hand, namely that the most excited nervous center takes the lead.

Ukhtomsky started to investigate the regularities of how such a “dominant” center is formed in 1904 after an unsuccessful laboratory experiment where the stimulation of a certain brain area of the animal did not give the expected motor reaction (limb movement), since the organism was prepared for another reflex activity (defecation). Further excitation of the nervous center speeded up the vegetative process, whereas the expected motor reaction of the limb could be induced only after the former was terminated. Ukhtomsky did not see this as a random experimental mistake, but as a manifestation of mutual influence of nerve centers on each other which possibly represents a common regularity and thus requires special investigation.

Assuming that this is not an anomaly but a rule, I started to think that what we see here is not only a rule, but *probably a highly-important organ of vital functions in the central nervous system.*

The concept of “organ” is usually associated with something morphologically determinate and stable, with static features. I consider it completely unnecessary, and it would in particular characterize the spirit of modern science not to see anything mandatory in this. *In my opinion and from my point of view, any combination of forces can serve as an organ that is able to lead to the same results every time in otherwise equal conditions.*

An organ is first of all a mechanism with a certain equivalence of action. This means that a complex of tissues is turned into a mechanism by the virtue of their physiological effect. There was a time when it was thought in mechanics that we need to understand the dynamics of a system on the basis of its static states. Mechanics was built from statics to dynamics.... The new science derives statics from dynamics [8, p. 124].

The main conclusion of Ukhtomsky was that during the excitation of nervous tissue (both in vitro and all the more in vivo), its reactions in fact do not show the stability expected from them.

Constant reactions in the same tissue can be obtained only under certain conditions in which we study the given physiological preparation. We also know that by altering the

conditions of excitation in the same preparation we usually obtain, as an evident rule, completely different results, or even the opposite ones, for example when excitation turns into inhibition [5, p. 75].

Ukhtomsky lists these conditions: quantitative characteristics of the stimulus (frequency and strength), functional mobility of the reacting unit, and the degree to which new central areas are drawn into the sphere of reaction. There can be many such centers influencing the reaction. The most active one among them forms the dominant.

Let the ganglion S receive an impulse “r” from a receptor. In this case the effect is a function of the stimulus received from outside: $E = f(r)$. Now let us assume the ganglion S is not relaxed, but has its own degree of excitation, and that it is not isolated, but surrounded by other ganglia, each of which can be in a state of low excitation. An approaching excitation wave can influence any one of these ganglia to some degree, and they can have a reverse influence on the wave, although ganglion S represents the most immediate recipient. In this case the effect is no longer the function of one variable. The equation can now be expressed as $E = f(r, A, B, C, D \dots)$. All these factors represent excitation values and “their influence on the observable reaction process does not anyhow differ in principle from what we’ve seen in the first case” [5, 75]. The most important difference lies only in the fact that these factors are now *internal*. Let us say that one of these factors D, which represents the “degree of excitation of a certain secondary center not far from the reflex arc you are investigating” [5, p. 75], has decisive meaning in the sense of its influence on the result. It is this center that Ukhtomsky would call a dominant.

This leads to one of the definitions of a dominant: “A leading focus of excitation which to a large extent predetermines the pattern of reactions currently occurring in centers” [5, 6] or just “a leading value in terms of its influence on the effect” [5, p. 35]. Talking about a “center,” we need to take into consideration that this term is rather simplified since various brain areas and other systems of the body are involved even in a simple reflex, not to mention a complex behavioral act. Ukhtomsky analyzes this problem on the example of the “speech center.”

...center figures not as a locally delineated area, but as an aggregate of areas that may be localized rather distantly from each other and are united more by their common activity than by constant links. All data confirm that a fully expressed dominant is a complex of specific symptoms in the whole organism – in muscles, in secretory activity and vascular functions. The dominant is conceived as a constellation of centers with heightened excitability on different levels of the brain and the spinal cord, as well as the autonomic system [8, p. 50].

Thus, an effective dominant encompasses various subsystems while it is active, in some cases extending to the whole organism. It is a temporal working organ that emerges to solve a certain task. The dominant is an “organ of behavior,” “although it is also mobile, like the vortical motion of Descartes” [5, p. 80].

Ukhtomsky delineates “two basic moments of dominance as a working principle of nerve centers:

1. The dominating center reinforces its own excitation through collateral impulses.

2. Together with the excitation development in the dominant, it inhibits other effective reflexes in the final common pathway” [5, p. 120].

As already noted, a dominant denotes a process. It has its beginning, main working phase and termination. The above referred features are related to the working phase, to a dominant at the height of its activity.

One of the essential questions of the concept is to answer how a center becomes dominant. Ukhtomsky gives it an experimentally-derived answer, although a qualitative, not a quantitative one. There are four features that characterize a potentially-dominant center. (These principles are not yet formulated in terms of the theory of oscillations).

1. *Heightened excitability*. The excitation threshold of a dominant is low. An indifferent stimulus can evoke a dominant only if this condition is satisfied.
2. *Excitation stability*. Excitation has already occurred, but it can “not be transient” in order to influence the course of reactions [5, p. 52].
3. *Capacity of excitation summation*. The capacity of a center to become dominant depends on its “ability to summate its own consecutive excitation states” [5, p. 52]. This in turn depends on the relation of oscillation frequencies and phases in the center and the incoming excitation wave. “It’s not the “excitation strength” of a center, but the “capacity of continuous excitation summation” under the influence of an incoming impulse that can make a center dominant” [5, p. 52].
4. *Inertia*, in which “the significance of distal waves is mainly expressed in the maintenance and acceleration of the established dominant reaction towards its completion” [8, p. 102].

Inertia is the ability to maintain an already existing dominant in an effective state over a significant time period, the “ability to sustain and extend an already initiated excitation state even when the original stimulus has already faded” [5, p. 52]. This feature is an obvious one when the dominant is formed by a chain of reflexes (e.g., swallowing) or by self-enforcing reflexes like salivation which can be evoked by the saliva that is already in the mouth. However, the most important feature of a dominant is its ability to use extraneous stimuli for its own purposes, which is typical of any dominant during the height of its activity. “This inertia consists in the fact that an already evoked dominant is able to persist for some time in the centers and reinforce both its excitatory and inhibitory elements by various and distantly related stimuli” [5, p. 38]. “While the dominant is vivid and lively in the soul, it maintains the whole field of psychic life within its grip” [8, p. 49].

How does a dominant fade? There are several ways for a dominant to terminate its work. This depends partially on the type of the dominant:

1. A dominant fades when some concrete act has been realized (e.g., swallowing). In this case the dominant is a chain of reflexes aimed at a concrete result, and its achievement will bring about the logical completion of the dominant. Ukhtomsky labels such inhibition as *endogenous*.

2. The second way to extinguish a dominant is *exogenous*. It consists in forming a new dominant that is functionally incompatible with the currently active one.
3. The last means of dominants' termination is through "direct" inhibition from the highest levels of the nervous system. Ukhtomsky compares such inhibition with the task of "not thinking about a white bull", a task of theoretical moralization.

It should be noted that the feature of inertia—enabling the dominant to persist for significant periods and to enforce itself through extraneous impulses—has also a second aspect, as it allows the dominant to fully reactivate itself with the help of fragmentary or external cues. "As the dominant fades, the sphere of stimuli capable of reinforcing it reduces" [5, p. 46]. The receptive field gradually returns to its earlier borders. But "a dominant that has been once evoked can occur again, even in an isolated spinal brain" [5, p. 46]. This is even more typical of the nerve centers of the cerebral cortex. Generally: "a dominant is characterized by its *inertia* not only in the sense that if once evoked, it will persist in the centers, but also—it can reactivate itself after it has faded" [5, p. 46]. "The dominant is characterized by inertia, i.e., by its tendency to maintain and repeat itself entirely when this is possible—even if the environment has changed and previous grounds for the reaction are gone. Dominants leave a solid, sometimes irreversible trace in the central nervous system" [5, p. 13].

This extremely important feature of the dominant justifies seeing it as a memory mechanism. "Several potential dominants can live in the soul at the same time—as traces of past actions" [5, p. 13]. The organism develops in the course of its whole life, while each event that occurs leaves a mark on its further activity as traces of experienced dominants. The realized dominants can fade and disappear later, or consolidate if similar circumstances reappear. This is how experience is formed. The reactions of the organism to current environmental signals are mainly determined by which dominants possess the highest degree of readiness at the given moment and emerge to the foreground. If a "suitable" dominant is not available, the signals can remain unnoticed or provoke an inadequate reaction. In various texts, Ukhtomsky compares dominants with a charged trigger, an explosion or catalytic process activated by an external signal. "Dominant: a large amount of potential energy carrying significant tension, which is easily discharged by different cues—like a decelerated explosion, caused by a spark" [2, p. 144].

A dominant appears to realize a behavioral act. While it lasts, it connects all the individual capacities and powers of the body to solve the given task. "Constantly differentiating, multiplying, and still not losing its unity; maintaining its harmonic diversity and coherence—this is the developmental history of the organism as long as it is achieved without disruption, defects, transgression" [8, p. 426]. This description already moves to the psychological level. It should be noted that Ukhtomsky always kept this level in mind and often illustrated physiological conclusions with psychological examples.

3 Dominants in Psychology

Ukhtomsky saw dominance as a universal principle. He compared it with the law of gravity, which is always effective, regardless of our understanding and evaluation. Dominance explains many aspects of behavior—perception in all modalities, motor control, and emotions. While it lasts, a dominant provides the integrity of perception—an “integral image.” Perception is not passive; it is subordinated to the current task through a dominant. We only notice things we currently need, everything else is ignored (and sometimes subjected to prejudiced interpretation). An integral image is stored in the organism and can later be reintegrated under different circumstances.

Emotions, controlled by subcortical structures, are linked with the images and motor skills of a given dominant and can then serve as a “flywheel,” thereby facilitating memorization, providing the continuity of behavior and connecting distant images and situations.

An emotion, as a continuous state of the soul is inert. Above all it deepens a dominant and lends it stability. That’s why it draws various contingent stimuli towards itself and “interprets them according to its disposition.”

It has an important biological role in the sense of a “flywheel that consolidates the direction of central nervous system functions into one particular effort, makes a dominant insusceptible to extraneous impulses, and leads it to specific achievements” [2, p. 139].

An emotional feeling underlines and reinforces the excitation (perception or action) which gives rise to it. It helps a perception or skill to consolidate itself in the mind and to take the place of an independent agent in memory. An impression not related to an emotional tone in the mind is destined to be erased from the soul relatively fast! [2, p. 136].

In the higher sphere of mind, emotions consolidate abstract conscious ideas as something living and concretely existing, making them a true “*idée force*” —the creative basis of human life [2, p. 137].

The emotional component of a dominant links the conscious and the subconscious, the past and the future, and helps to understand the role of dominants in determining behavioral motives. The famous psychologist and historian of psychology M.G. Yaroshevsky referred to dominants as underlying the motivational potential of behavior [11]. Dominants explain active behavior, as well as the organism’s active relation towards its environment.

Let us once again underline the important idea that the mechanism of dominance allows for describing known psychological regularities in general terms. Not only motor control and skills, but also motivation, emotions, mechanisms of memory, attention, and objective thinking can be described in terms of the dominance concept. This circle of ideas ties together related terms in the psychology of motivation, cognition, communication and personality as they are considered in modern psychology. Mechanisms of dominance can also easily explain known pathological phenomena of the psyche. The inertia of dominance can disturb normal behavioral regulation and become the source of obsessive images. If there is a malfunction in switching from one dominant to another, reaction conflicts may occur. Thus, the mechanisms of dominance can evoke and reinforce pathological

processes. The principle of dominance can be useful also for the psychology of work and pedagogy by explaining the processes lying at the basis of learning, exercise, fatigue, the ability to concentrate, etc.

4 Ethics. Dominants Facing Another Person

Ukhtomsky's vision of ethics is highly interesting. The importance of social components in all aspects of psychological activity is taken for granted by him. He wrote that we all are born, live, and die in society, and a special language is needed for describing the social not to reduce it to biology. The life of society at large is subordinated to regularities that are similar to the regularities of dominance. For example, he wrote that the Revolution had been growing for a long time and could be triggered by any concrete occasion. The events of 1917 were not the reason, just an impetus for events that were already prepared. Yet, society consists of different people. Let us recall that Ukhtomsky created his concepts at the beginning of the Soviet period, when our country followed the motto that the "social is above the private." This was not true for Ukhtomsky. "Neither the common, nor the social can be set above personality, because they are made of persons and for persons; and a person cannot be opposed to the common and the social, because a man becomes a person only by devoting to other persons and the society" [1, p. 267].

The question of interpersonal relations is the most important and cherished one for Ukhtomsky. Based on the principles of dominance, he formulates the laws of the "double" and the "condign companion." "Our dominants stand between us and reality. The general tones in which we see the world and people around us depend to a vast extent on our dominants and who we are ourselves" [8, p. 142]. If we are unable to overcome our egocentrism, then we will see our own limitations and flaws in our companion. We will see our own double, as Dostoyevsky said, instead of a companion. If we judge someone, it often turns out we judge the flaws we do not want to admit in ourselves. But if we idealize our companion, we raise the norm for both him and ourselves, and acquire the opportunity of moral development. The companion is for us one who we deserve. Let us consider a more extensive quote to understand what is meant by companion.

According to the dominance principle, when meeting someone, we mainly see what this meeting arouses in ourselves, but not who that person is. How we interpret a person (by our own yardstick) that we come across predicts our behavior towards him and, in turn, his behavior towards us.

In other words, we always find in our companion what we deserve. Meeting a person reveals and exposes everything that was hiding inside us; and we face the most truthful, realistic, objectively solidified trial over what we have secretly lived by and secretly thought of ourselves.

Thus in a social aspect, the principle of dominance turns into the law of condign companion. If a person you meet is bad for you, you deserve him as such – he could be good for others! And it is your own fault that the person has turned his worst sides to you. The most precious and essential in human life lies in the communication with other persons.

However, the tragedy is that man actively approves and consolidates in others what he suspects of them; and what you suspect of others is usually what you carry inside yourself.

A malign person sees above anything else the bad traits of others, and thus provokes them to bad deeds, lowers them to his own level; this way we infect each other with what is unwholesome and obstruct the path of our own growth – and reaching the beauty that can actually be concealed in another person [1, p. 479].

An idea for overcoming such lowering communication follows this explanation: a perspective for building truly human relations.

An ability not to linger in your abstractions and at all times be ready to choose living reality instead, to know how to approach each person in his own right, to be able to enter his shell, share in his life, to understand his starting points, to understand his dominants, take his point of view—that's the task [8, p. 149].

Infection with ignorance is something that happens very easily all by itself. Infection with the good is only possible by working with oneself, by actively not allowing oneself to see bad things in others and focusing only on the good. Here is the deep difference of whether we understand “equality” to mean that—see, both of us are unworthy, or in the sense that I can and try to become as noble as you.

We have to recognize that overcoming oneself and developing a bright creative dominant facing another person come very easily and are granted anywhere where there is love: “he sold everything he had, and bought the village where the pearl is hidden” [1, p. 479].

So the substance and the quintessence of Ukhtomsky's ethics lies in the development of *dominants facing another person*. The straightest and shortest way there is: love. “Only as much as we overcome ourselves and our individualism, the leaning on our own selves, are we able to see another person. From the moment the other person becomes revealed to him, a man deserves to be called a person himself for the first time” [8, p. 150].

An important case of the law of “condign companion” are the relations of grownup children and their parents. Ukhtomsky considers this problem in the form of commentaries to Blok's poem “Revenge.” Children-revolutionaries who overturn and destroy the world of their parents simply bring to a logical close the contradictions and mistakes which their parents were once unable to overcome. Ukhtomsky considers the revolutionaries as the unhappy children of unexemplary parents. That is why, even in this case, the occurring tragedy is a moral-historical judgment, and the most appropriate, if not the only, way to solve this problem is through love.

As Blok thinks, and I highly empathize with this idea, the new generation is a consolidation, a realization and embodiment of the inclinations and unclear intentions that were secretly harbored by their fathers and forefathers! And whatever was hidden then, is now openly preached from the very cradle. What was barely thought of is now acted out in real history on the streets.

For the blind exchange of human generations, children are essentially the “condign companions” —the historical vengeance to their fathers. At the same time children are also an augmentation of love to them and the living realization of a future world.

The genealogy that Blok writes about in his poem is of a consecutive devouring of fathers by their children, just like in the genealogy of the Roman Caesars or of rats and rabbits. (Simplicity and extremes, yet they fit well!). A completely different legacy runs from the father of Abraham's tribe through Isaac and Yaakov until Christ—a continuous evolution of love as principle of life [1, p. 480].

Let it be noted that “facing another person” is a subject that Nadin [12] pursued in more recent years with the claim that minds exist only in interaction with other minds. Ukhtomsky would have been interested in this thought.

5 Hierarchy of Sciences

We can see that Ukhtomsky, starting with dominance as a physiological mechanism, switched to a discourse on Christian love. After all, that was his main goal—to “justify” Christian belief with science. It is namely due to this that various distortions in the interpretation of Ukhtomsky’s work have occurred on both sides of the debate. Depending on the reader’s viewpoint, the author’s belief either attracts or repels; in both cases, this leads to prejudiced opinions and superficial reading of his texts. At the same time Ukhtomsky’s thoughts deserve to be investigated closely and seriously, and to leave out the Christian aspect would be wrong, as without it the picture would remain incomplete. Of course, entirely physiological or psychological problems of applying dominance theory, as well as the question of mathematical description and modeling, can be successfully viewed separately from its philosophical basis. But this would not be the complete Ukhtomsky.

One of the milestones in Ukhtomsky’s concepts is the idea about a hierarchy of sciences, which he had already conceived in his youth. Ukhtomsky came out with a consistent and highly convincing rejection of reductionism. Reductionism is based on the possibility of explaining the behavior of a system based on the behavior of its elements or subsystems. Ukhtomsky took the opposite view—the behavior of a subsystem is determined not only by its own internal features, but by its place in the whole system. The elements and the system as a whole may require different levels of description. Various sciences differ in their language of description, which should be adequate to the level of observed phenomena. In Ukhtomsky’s view, lower level descriptions do not give us any knowledge about higher level phenomena and laws. For example, geometrical terms describing the form of solid objects cannot explain the regularities of their motion. Although the laws of mechanics do not in the least contradict those of geometry, and although the form of an object can be relevant and can be considered when describing its motion, on the whole it’s still not geometry that defines motion; and the latter has to be described in terms of speed, acceleration, etc., and here it is often possible to abstract away from the form. Attempts to describe something in lower level terms either fail or lead to awkward and bulky constructions; the more complex regularities of higher levels cannot be captured in terms of lower level descriptions.

Ukhtomsky sees the hierarchy of his contemporary sciences as branching in the following way:

Real physical world is a pure accident from the point of view of geometry, the world of real chemistry is an accident from the point of view of physics, life is a pure accident from the

point of view of chemistry; the law of good and evil (law of retribution) is a pure accident from the point of view of biology. This is a typical chain of rising links, when it's constructed from below. But if you move downwards from above, the place of each lower link in the life of the higher unit is obvious! [3, p. 224].

With regard to the problem we are currently interested in, the question is whether psychological phenomena can be described in physiological terms. Ukhtomsky considers that all psychological laws should be described in their own psychological terms. Talking about physiology, its laws do not contradict the psychological ones, but also do not explain them—just like the laws of geometry do not contradict those of mechanics but also cannot pretend to explain them, as the former are a “provincialism” in Ukhtomsky’s expression in relation to the latter.

We should stress once more that dominance in physiology results from physiological experiments and physiological observation, yet the description of dominance as a process has some analogies with the psychological level. Based on the mechanisms of dominance, Ukhtomsky formulates several laws pertaining to the psychological level which can already be attributed to the moral sphere: the law of “condign companion,” the “law of retribution.” They do not contradict psychology, but from the perspective of pure psychology they are not necessary, they are “accidental.” And such matters as overcoming the “law of retribution” with a higher “law of love” already belong to moral or religious levels.

The originality of Ukhtomsky as a thinker, whether we agree with him or not, lies first of all in his ability to see everything as a whole. Higher level laws exist on exactly this level. The lower level cannot dictate them; it is neutral in relation to them. In some sense the possibilities of a lower level are wider; they are redundant, whereas the higher levels constrain them, draw additional borders. “Out of the law of love and mercy, out of the law of good and evil, as the most concrete and substantial ones, we can—with various degrees of abstraction—deduce the laws of history, sociology, biology, chemistry, and mechanics” [3, p. 233]. This is a view of principle for Ukhtomsky, as it reflects the relation between his scientific views and moral and ethical beliefs.

We consider the aforesaid to be important for understanding the scientific position of Ukhtomsky, though it is hardly accepted by the majority of the modern scientific community.

6 Attempts at Formal Description

Due to the pronounced ethical-religious direction of Ukhtomsky’s work, one may think (and this happens quite often) that it is a “humanitarian” line of study, containing very little concreteness and too much “verbalism.” However, we consider that Ukhtomsky’s legacy is not researched enough in terms of “positive science” not because of its humanitarian dimension, but because its “positive-scientific” component is rather difficult, and currently there is no worthy successor able and ready to carry this heritage forward. Let us illustrate this

statement first with an enumeration of approaches, which Ukhtomsky transcended and rejected (though many of them still exist and we have only begun to realize their limitations). Second, let us recall the similarity of Ukhtomsky's ideas [13–16] with the ideas of modern post- and non-classical science, or synergetics [17]. And last, let us discuss the attempt made by Ukhtomsky at the very end of his life to apply mathematics to the description of nerve centers' functioning, using an equation of nonlinear oscillations.

Dominance seems to be a simple and self-evident principle, as there certainly should be a united control center for holistic actions and behavioral acts. By observing which modern approaches Ukhtomsky rejected, we see to what extent the concept is not self-evident. Above all is the reflex theory. Within reflex theory, the organism is considered simply as an aggregate set of reflex arcs. Instincts were similarly considered as fixed structures with invariable reactions to external stimuli. Pavlov introduced time-dependence into reflex reactions, but this dependence was a superstructure added to a constant set of reactions. On the contrary, Ukhtomsky considered constancy as a special case of variability. "A reflex is not an element, but a fragment of motion. And the whole is not the result of compounding reflexes, but an integration of action moments" [3, p. 228]. These are two opposite theoretical approaches. "Reflection, of course, is reflection, not a passive and instant given, but a historical achievement as the ability to capture, perceive, attend, and reflect new sides of existence develops" [2, p. 246]. It is not passive because it is determined by internal adjustments no less than by external stimuli. The aforementioned definition of an organ as a temporal structure is in line with this approach. Rejecting the reversibility of time also corresponds to it. Studying the laws of nature as constant leads to the use of a mathematical apparatus where time can be reversed, i.e., flow backwards. Such are the laws of classical celestial mechanics, for example. In historical sciences, time is fundamentally irreversible. After a certain event has occurred, for example, the victory of Russia over Napoleon, everything follows a different path. That is why, unlike in mechanics where time is a feature of motion in three-dimensional space and all motions are equal, in history "the frame of reference" is a consequence of consecutive events, and you cannot move backwards in it. Studying living systems—animals and man—Ukhtomsky does not refrain from considering their natural, material basis, but places them in a historical coordinate system. And this approach is indisputable, as the life of any living being from conception till death consists of unique, unrepeatable events.

In analyzing the organism's energetic exchange with its environment, Ukhtomsky decisively rejects the principle of least action and the mathematical optimization mechanisms corresponding to it. Ukhtomsky considered the goal of any living creature to be the unleashing of its own potential possibilities as much as possible, and not in the limitation of environmental effects. "In the sense of least required actions, let us consider the most successful organism that has gained a lucky opportunity to produce minimum work in the environment. What examples from biology do we have? First of all, these are immobile parasitic forms" [8, p. 136]. During its activity, an organism "extracts" energy from its environment.

The more active the work is, the more intense the energetic exchange. That is an open system, a non-equilibrium process. As Ukhtomsky writes:

In case of a regular relation to the environment, the organism is bound to it in the most intimate way: the more it works, the more energy it extracts from the environment, the more energy it captures and incorporates into its own processes. It is clear that it is namely the strongest agent with most powerful workings of the central nervous system who is able, throughout life, to bind and process maximal amounts of energy from the environment and to incorporate them into his own work, so as to produce by his activity powerful and long-term after-effects, which give reason to remember this individual, even when he is already long gone [8, p. 135].

The energetic exchange properties of living beings were studied on the cellular level by his students and followers only after Ukhtomsky's death. Arshavsky showed that during the work of skeletal muscles, i.e., during organisms' motor activity, a surplus of free or structural energy is generated, which raises the efficiency of the developing organism. This is the difference between the "functioning" of non-living systems and the development of living organisms. The irreversibility of time for living systems consists here in the conversion to a higher energetic level during muscular work. If we consider the organism-environment system, the overall amount of energy received from the environment and used for work—i.e., accumulated in the organism and dissipated in the form of heat—stays the same, only performance efficiency is increased and heat losses reduced [18]. Kondrashova discovered that the surplus effect relates to action also in its biochemical aspect [19].

Ukhtomsky rejects reductionism in all its forms. He considers that the whole is not the sum of its elements. On the contrary, an "element" is always dependent on its place in the whole system. For example, in the context of visual perception this means that a whole image is not conjoined out of elementary sensations. To the contrary, the incoming sensations are perceived based on the general anticipated image. "Of course, the truth is revealed to man through "sense organs," yet not by them! The presence of real living truth won't give anything if man is not internally prepared to perceive it! An adequate preparation of the whole person in his ongoing history is needed to notice the truth" [3, p. 254]. Further, Ukhtomsky states:

Here we have a much more principled question of the whole-part relation, after all! Sensation is considered as a part of perception as a whole. So we can say that perception is composed of sensations and represents a secondary product of primary sensations (psychological atoms), or that perception is the primary integral, and sensations only exist as derivative abstract elements, artificial analytical functions of thought! [3, p. 265].

If we compare these viewpoints with existing approaches in computer modeling of visual perception, we are able to see similarities with, for example, Minsky's "frames." The entire sphere of visual perception based on a priori models belongs here.

When Ukhtomsky discussed neural networks models he opposed viewing them as switching schemes, where single neurons act according to the "all or none" principle. Understanding the convenience of such a simple scheme for the

construction of numerical models, he nevertheless listed the experimental facts which cannot be explained by this scheme. These include decremental decay, deceleration of rhythmic conduction in inhibited nerve regions, the possibility of group excitatory discharge in response to a strong impulse, etc.

No doubt we are to welcome the time when the physiology of excitation will become a mathematical science. It's in this regard necessary to say in advance, however, that the mathematical construction of a theory of excitation on the basis of the "all or none" postulate will remain a particular and exceptional theory, similar to Euclidean geometry. The future mathematical physiology cannot avoid the task of measurements within an "elementary excitation" [20, p. 32].

At the very end of his work, in 1940, Ukhtomsky took a step towards building a mathematical model of excitation in the nervous tissue. He followed here, as usual, the holistic principle, and considered that the regularities that govern the whole system require separate investigation, while the features of single waves would be determined by these general regularities. On these bases, Ukhtomsky proposed the concept of physiological excitation as an oscillatory ensemble. Referring to the results of Van der Pol, who successfully applied a nonlinear equation of relaxation oscillations for explaining heart rate, Ukhtomsky suggests following the same idea to explain the set of facts gathered on nervous tissue excitation.

We bear in mind the following set of phenomena:

- (a) Upper and lower frequency and power thresholds within which external impacts produce an effect in the oscillatory system
- (b) Protraction of effect frequency, akin to the inertial lag of an oscillatory system with respect to rhythmic impulses
- (c) Phenomena, analogous to single tetanic excitation (combined resonance)
- (d) Forced synchronization phenomena, equivalent by content to the assimilation of rhythm
- (e) Frequency division, conversion of input rhythm into multiple effect rhythms
- (f) "Autoparametric filtering," corresponding to the selective conduction of oscillations through a parabolic site
- (g) Dampening influence of one oscillation sequence with certain amplitude and frequency on another oscillation sequence with different amplitude and frequency

In Van der Pol's general equation of relaxation oscillations

$$u'' - a(1 - u^2)u' + \omega_0 u = \omega_1^2 E \sin \omega_1 t$$

a continuous change in the value of a leads to a transition from continuous Thompson type oscillations to discrete relaxation type oscillations. At this point the regularities of ongoing oscillations change—the system acquires new features, and its former features are diminished. For $a < 1$ we obtain complete isochronism and independence of amplitude from frequency, at the same time for $a > 1$ there appears a significant dependence of frequency from amplitude. For $a < 1$ resonance is a main feature, and for $a > 1$ it is almost absent. For

$a < 1$ the system is easily disturbed by external influences in terms of changing its amplitude, yet its “own rhythm” is steadily maintained. For $a > 1$ its frequency changes easily, but the amplitude is steadily maintained. The principle of superposition is applicable for $a < 1$, but not at all applicable for $a > 1$.

In nonlinear systems a low amplitude rhythm can be imposed by a strong unit, and the key to domination is created through a tactically selected and persistently maintained rhythmic influence of a “weak” component on a “strong” one [20, p. 163].

We have provided this extensive quote from Ukhtomsky’s work because it is the only attempt, as far as we know, at mathematically describing physiological experimental material made by Ukhtomsky himself and his followers while he was still alive. Here, we refer to a single nervous center that can be in a dominant state. In the general framework of dominance multiple centers must be considered, and the theory must explain how and why only one of them becomes dominant in the course of their interaction.

Ukhtomsky’s followers continued to study the possibilities of applying the theory of nonlinear oscillations to physiological processes; they created a system of equations not for a single, but for a group of interacting oscillators [21, p. 80]. But, as far as we know, none of these mathematical models have been studied in sufficient detail to compare them with the results of physiological experiments.

We should also note that the processes of dominance studied by Ukhtomsky and the various processes of nature discussed in synergetics are analogous not only because of the features we have already discussed (irreversibility of time, openness, and non-equilibrium), but also due to the presence of two stages in the process of dominance: stability and bifurcation. The stable stage—the dominant at its height—is deterministic, allowing for near-future prediction of the course and result of a process already begun. The stage of switching from one dominant to another allows multiple options for further events to develop, and even very weak additional influences can significantly change the course of the process.

For many years, there were very few known attempts to model different aspects of dominance mathematically. One of the earliest among them was the work of the academician N.M. Amosov, who was famous in the 1970s for the inhibition reinforcement system [22]. The neural network is presented here in the form of interconnected ganglia, and the excitation level of each ganglion is determined by the overall summation of excitation received from other ganglia. As seen below, the model is highly simplified and does not take several important aspects of dominance into consideration. Another model was developed much later by V.I. Kryukov (Father Superior Feofan) and was dedicated to attention modeling [23]. Beginning with the 1990s, oscillatory neural network models were successfully applied to modeling attention, memory, visual and auditory perception [24]. These studies have continued to the present day. They usually do not consider problems of energetic exchange with the environment, or the problems of motivation and

transition from one activity to another, which are central to the theory of dominance. From this point of view, we can compare and find analogies of Ukhtomsky's theory with genetic algorithms, scenario modeling, etc. Attempts to apply oscillatory network models to solve such problems are still unknown.

7 Cognition as an Aspect of Activity. Experience— Hypothesis—Experience. Chronotope. Intuition

Let us now discuss how a dominant can serve as an organ of anticipatory cognition from Ukhtomsky's viewpoint. We should once more emphasize that anticipation is seen by Ukhtomsky not as a separate kind of intellectual activity, but as an inherent attribute of any activity. Not only the organism, but reality itself is considered by Ukhtomsky in a historical manner, within time, an irreversible process. That is why cognition is also understood not as the discovery of static, everlasting regularities, but as an increasing involvement in the surrounding life that is acquired and developed over the course of one's own life. Humans become aware of the reality surrounding them, act within it, change it and change themselves. All of these are different aspects of one process. "A man is active in forming the integrals of his experience and his truths" [1, p. 363].

Man's thought is his action. This idea corresponds to Nadin's conception that anticipation is always expressed in action [22]. Talking about man: "If he thinks about the world in a certain way, then this is how he acts in the world. Among people, he acts according to his thoughts about the world and people" [1, p. 465]. This idea was later developed by N.A. Bernstein, who suggested that any thought has a muscular expression, and only through this can it become known to others, i.e., through action, speech, written speech, and imitation.

From Ukhtomsky's perspective, the ability of increasingly precise anticipation is determined by how deeply one is tied to reality. To anticipate is not just to set a goal and lay down a plan of action towards its achievement in some formal or mathematical language, as it is often considered in artificial systems. Neither is it for Ukhtomsky identical to the principle of feedback as understood by Wiener, although the idea of action correction in the course of goal achievement is naturally also present in his work. In artificial systems it is usually assumed that the model of the environment can be described in formal terms, and the goal state is one of the possible states in this model. Accordingly, it is in principle possible to realize the plan; hindrances and unwanted side effects exist in the form of limitations in terms of the same formal language. However, in real life we have to form our behavior within informal reality, sometimes totally unpredictable, and always wider than our data about it. Moreover, after Freud's discovery of the subconscious (a theory that Ukhtomsky admitted and used with some major reservations), it became obvious that even with adequate understanding of the task and its solutions, we cannot always predict and control our own behavior.

According to Ukhtomsky, when a new situation appears, we think and act based on the experience we have encoded in the form of dominants that are ready to work. The organism reacts and behaves in the way it is ready to react. Instances of inadequate reaction are not infrequent, for example, when a person is angry or obsessed with something, and a completely accidental occasion can provoke the prepared action. But even in most adequate reactions, a dominant is an “experience in action.” It never wholly covers the new situation, and therefore necessarily contains a prediction, anticipation of new experience, and it is checked and reinforced only through new experience.

A hypothesis is an anticipation of experience. Psychologically it always has its reasons to appear, thus it has psychological relevance. But its true goal consists in verifying to what extent anticipation matches real experience [2, p. 130].

Based on already known facts, the synthesizing thought creates a model of reality. Whether it is an adequate one is decided by the future, as only future confrontation with unaccounted facts can evaluate this model. However, if a coherent model was constructed by one or another means, this indicates it had sufficient grounds, and the underlying dominant set was confirmed by evidence. By constructing a model (integral image of reality), man won his struggle for the model’s existence, i.e., he was able to project a future. Through man, existence projects its own future, since man’s share is not only to build models by drawing on the past, but also to struggle in carrying them to the future [3, p. 440].

The historical approach consistently applied by Ukhtomsky leads him to several basic postulates and concepts. Definition of the “chronotope” is one of them. In linking time and space, Ukhtomsky followed Minkowski’s theory, which confirmed that the ideas of separate space and separate time are but shades of reality. The actual measure is an interval between events, where time and space are united and interchangeable. The distance to a nearby city can be measured in kilometers, or hours spent for travel by car or on foot. From the viewpoint of the model that anticipates reality, these are complementary descriptions. Ukhtomsky uses the concept of chronotope also in another sense, related to the ability of harmonization and synchronization of events. This was already seen with reference to dominance. “The assimilation of rhythm,” the coordination of time, speed, and rhythms, is a precondition for forming a functionally unified system out of spatially segregated elements. This relates to the human brain, but also to social and natural phenomena. However, for Ukhtomsky the concept of chronotope found its main meaning as an analogue of dominance, not with reference to neurophysiological processes, but to external and mostly social processes. “World lines,” chains of events in space-time, reveal historical regularities where what passes never disappears without a trace, and the future is never strictly determined by the past, though it arises from past events.

Nothing passes without leaving a trace. All foregone will be accounted for. What comes to light is only what was hidden inside. What is gone, but requires external conditions and time to grow in order to open and reveal itself. That is the dominant in man, and the chronotope of Existence! [3, p. 380].

An event is a meeting in a person’s life, an interception of his inner dominants and the world lines of external reality, a practical verification of his truths.

While a dominant is at its height, the internal chronotope and the external chronotope develop in direct correspondence for a period of time. This is a truly visionary understanding and sagacity. A dominant becomes coupled to the chronotope and adequately perceives its content at a given moment. And this is of no surprise, as the dominant is a part of it! And a fully adequate relationship is obtained now between what is sought for and what is realized [3, p. 269].

After an act is performed, its adequacy can be experimentally verified. In this case, we can only speak of a very limited anticipation in time and space. An action with instant feedback, usually, does not require and does not interact with complex dominants and large segments of memory. Ukhtomsky compares such actions with touch. It does not require, or almost does not need, a priori information and hypotheses. It can be a “blindfold” move.

As opposed to such actions, anticipation over significant time-space intervals is compared by A.A. Ukhtomsky with visual perception. Vision is in principle impossible without hypotheses, a priori information, models, as available information is never sufficient to see everything. That is why illusions and mistakes are possible in visual perception. The verification of visual hypotheses can be deferred in time or distant in space (for example, you might need to move towards the object to see it from the other side or to touch it). Touch allows for closer verification and more precise reproduction, but within a much smaller range. Alexei Alexeyevich loves this analogy and often applies it to higher levels of consciousness: interpersonal relations, comprehension of historical regularities, etc. Visual perception always supposes faith as a hypothesis and plan of action.

Building a tactile model based on visual experience; building a visual model based on auditory experience; building a visual auditory model on the basis of any new experience—these are constant *physiological facts*. *The anticipation of distant reality and the preliminary construction of a likely reality are typical facts of brain activity*, which spread and grow in their movement towards reality.

Thus idealism, the constant building of ideal models, belief in an ideal future reality as an already manifesting fact—although these anticipatory visual models seem phantasmal and deceptive at least for the near-sighted touch, they are a direct consequence of our physiological *modus operandi*! The near-sighted “truth” of the closest tactile experience can devalue and even deem illusory the distant visual foresights of an astronomer or a prophet. But for a whole-hearted, active and developing person there is no absolutism of tactile presence when he foresees a new, distant visual image of future experience! [8, p. 312].

There is a “law of relations,” according to which the truth is anticipated and preliminarily given long before there is 1) direct contact with it; and 2) it unfolds on the historical plane. That’s why preliminary statements about it are always in the form of “beliefs,” “convictions,” “models.” Truth for the participants of this unfolding process is “faith” [3, p. 269].

(For more on relational aspects of anticipation, see Nadin [25, 26].) An analogy between visual perception and anticipatory cognitive activity helps to understand another important aspect of Ukhtomsky’s ideas. In itself, the ability to perceive the response to our actions, to realize if we are correct in our insights and deeds is also not constant. It exists in time and changes with us and with the surrounding reality. Understanding the results of our activity is, by itself, a cognitive activity based on our dominants. Growth is necessary to attain proper understanding, and it will never

be complete. In this sense man learns his entire life, as Ukhtomsky said, always reintegrating his world view. Truth is always ahead of us, and it obliges us. We are able to assimilate only a small part of something that always remains bigger than who we are.

It is natural for one's own realizations to subside and crystallize into certain constants as they are created in your soul. But this is also what turns them into artifacts and fragments of life, different from living life in its wholeness. Be sure that the living life from which they crystallize is wider, and cannot be contained by them, can never be exhausted by them, and will always yield new contents, since "experience is always new"—as Goethe rightly said. We need to be wider than our crystallizations!

Living life always escapes the net of your realizations, charges ahead of them, grows, draws you along, calls you to become higher than you are [8, p. 330].

The wider the field of activity that the deed is related to, the longer it takes for consequences to appear, the harder and more responsible the anticipation becomes. Here Ukhtomsky talks not only about eternal approximation towards the truth, but also about the judgment—the objective trial, the reaction of reality to our actions, based on our hypotheses and understanding.

Truth is given to us through experience, in the form of uncertain and for some time "vexing experience"; so when the Truth presents itself, the human mind cannot be satisfied, what to speak about total satisfaction! It's an old and very harmful prejudice that Truth is human satisfaction and exists to satisfy man! It is a trial—and a dreadful judgment. It is recognized and revealed in experience if man has developed appropriate receptiveness, and to the extent such receptiveness towards oneself is developed in man, it raises him higher and higher. Here lies the path of man's elevation ever higher in his progress and work! [1, p. 462].

In the same way, scientific cognition is understood as an unending pursuit of understanding the truth, leaning on all former experience. Based on the dominance principle as a principle of dynamic development—and from a mistrust towards constancy and dogma—Ukhtomsky considers the influence of the subconscious and confirms the leading role of intuition in scientific cognition. Talent is seen as a special gift for profound intuition.

Science is called science because we learn through it something that is bigger than us, something that we don't know and could not know on our own, something which we see as being above us, as given by someone who is much greater and from a place that is much greater than us. Taught by the legacy of history; the sprouts of humanity lie in history—and in what still awaits. The role of science isn't, of course, to insist on what it prefers at all costs, but to reach out in pursuing the future [1, p. 457].

As already noted, explanations of cause-effect relationships are, according to Ukhtomsky, sufficient only for systemizing already occurred events, for the past, but not for the future.

When thinking about the past, about what has already happened, the leading category is the *causal one*. The category of goal is expressed in thoughts about the future and what is anticipated. Full-fledged human thought is always directed towards the future, it is always pragmatic and purposeful—man can devote himself to an exclusively causal description of reality only in abstraction and reduction, when you can turn your attention exclusively to past events and when present reality is just a repetition of the past.

Full-fledged human thought always tries to project new realities. And all knowledge about the past, from the perspective of the causal category, plays only a subservient role to better project a new reality [8, p. 294].

In line with the above, Ukhtomsky sees the role of logics, verbal argumentation, and formal methods in science as completely subservient, designed to explain, verify, and systematize already present knowledge *post factum*. Dividing cognitive activity into levels and treating it as a hierarchic structure (an approach accepted by most modern psychologists in Russia) isn't very characteristic of Ukhtomsky. However, the logical, formal, and theoretical levels are not the highest ones for him, since this is the level of simplification and reduction, often distorting real life in favor of a convenient scheme. Formal structures often cannot bear experiential verification. "It was conceived so well, yet experience says something else! That's the tragedy of abstract theory. And that's because objective experience is always new!" [1, p. 458].

Abstract theorization based on a logical scheme is the opposite of intuitive cognition, which is based on the play of dominants.

Intuition or "clairvoyance of reality" is this: there is no discursive justification of truthfulness, but its empirical justification always lies ahead, in the present moment, where willpower, decisiveness, action, determination, and "undertaking" are required [3, p. 269].

We call "intuition" the elusive thought in its natural state that passes even before words. It is always the first to occur in us. Our further task is to embody, reveal this intuitive thought—coming from the unknown and returning to unknown, almost always "wise as a cat"—in the slow and inert speech symbols with its "logics," with its "argumentation" and "conscious evaluation." However, logics and argumentation are only following the intuition, attempting to rebuild, verify and justify its meaning. Yet its meaning and wisdom don't lie in logic, argumentation, nor in its further explanation; it lies instead in pre-conscious experience, in the play of dominants granted by the inherited legacy! [8, p. 332].

Talking about the legacy of inheritance, Ukhtomsky was sure that certain traits of worldview and behavior are brought and accumulated from generation to generation and are thus national. In the sense of cultural continuity this is beyond doubt. Alexei Alexeyevich believed that physiological dominants can also be inherited and compose the historical basis of morality. "Conscience is really an inherited, organic, preconscious legacy of judgment" [3, p. 269].

According to Ukhtomsky, talent in science consists of a deepened sense of intuition. It depends on the richness of dominants and their speed of alternation, and accordingly on inborn abilities and their correct development.

Talent consists in the ability of seeing clearly the complex dependents and architectonics of a thought as a whole construction all at once. Suddenly, perspectives open up in thought for linking chains of phenomena and ideas into a single entity, into an integrated image of reality. In further discourse one only needs to lay out, reveal, and provide a clear and compelling explanation to everyone of what was presented to him in the initial integral form. This is the same in mathematics, music, poetry, and any science: philosophy is no exception. This is the "original synthesis," which so surprisingly anticipates links with reality; it's a model of reality about which we can only say whether a given person possesses it or not, since it's an ability of individual nature, and a matter of giftedness, just like the individual abilities of vision, hearing, and association! [2, p. 139].

8 Conclusion

The creative legacy of Ukhtomsky has not yet been exhausted. It must be investigated through the united efforts of psychologists, philosophers, physiologists, and mathematicians. The psychologist V.P. Zinchenko stubbornly insisted on this [27]. As an epigraph to one of his articles on Ukhtomsky, he chose this line from the poet Osip Mandelstam: “Yesterday is not yet born.”

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