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Contemporary cognitive science: the transdisciplinary approach and the problem of consciousness

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The current state of cognitive science is discussed in this article. It is argued that cognitive science as it currently exists is not a separate, independent science. It is represented by a scientific interdisciplinary community focused on meeting the key challenges posed by the present time. The objective of the discourse in this interdisciplinary space is to generate new knowledge that it is impossible to generate within the frameworks of separate scientific disciplines. Some features of this new (transdisciplinary) stage are emerging within on-going interdisciplinary research. One of the signs of the new stage is the outlining of a merger of humanitarian and natural-scientific knowledge. It is claimed that the transdisciplinary approach can be considered as "a creative polylogue" of monodisciplines capable of generating knowledge that is not available to any science and the acquisition of which is beyond the abilities of any science.

Keywords: cognitive science, development of scientific cognition, interdisciplinary stage, transdisciplinary stage, "creative polylogue" in science, natural-scientific approach, humanitarian approach, complementary interaction, complimentary interaction

The problem of consciousness is gradually acquiring special significance within the list of problems still waiting to be resolved. Interest in the subject and problem field, rather vague outlines of which are being objectivized by the psychology of consciousness, is today becoming increasingly prominent. This process has it own foundations. Research on consciousness is becoming a priority because it turns out to be at the core of the problem of contemporary cognitive science. This problem can be defined through the triad "thinking–consciousness–brain."

By understanding the genesis of cognitive science as an interdisciplinary discourse, one can reach the conclusion that this discourse itself is inspired by processes occurring at much more global levels than are the processes occurring in particular sciences or interdisciplinary scientific fields. Sustained attention to the problem of consciousness is caused by the entry of modern civilization into a new technological setup that brings to the forefront the anthropological basis of technological transformations that make high demands on human psyche and consciousness.

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Thus, one can agree with Chernigovskaya that "we should lay our hopes not on even more complex abilities of technologies to resolve problems, but on methodological and even philosophical breakthroughs that must lead to a new multidisciplinary scientific paradigm" (2010, p. 15). At the same time it is important to define the notion of *multidisciplinarity*. If we understand multidisciplinarity as being close to similar concepts, such as pluridisciplinarity or interdisciplinarity, then we can understand *transdisciplinarity* as a principle of the organization of scientific knowledge that opens up a lot of opportunities for the interaction of many disciplines in solving complex problems of nature and society.

Given this understanding of transdisciplinarity, cognitive science is not a monodiscipline but a scientific community that includes representatives of different sciences who are able to understand each other and who are aware of their contributions to the solution of the global problem that the community has gathered to solve. This novel organization of the field of cognition has been aided by cognitive science. Until now science has been a well-structured corpus of scientific monodisciplines, perhaps even "split" into two camps: the natural-scientific and the humanitarian. Psychology occupies a strategically important place between these two blocks, although until now it has seemed that this forced "bilingualism" is the basis for the "permanent crisis" of not allowing the science to determine itself which camp it should affiliate itself with. Jean Piaget claimed already in 1970 that after the stage of interdisciplinary research "one should expect a higher stage–transdisciplinary–which will not be restricted to the system [of having] clear borders between the disciplines" (Transdisciplinarnost', n.d.).

Within the stage of interdisciplinary research, which is far from being completed, some features and attributes of the new (transdisciplinary) stage have started to emerge. Prior to other scientific disciplines, psychology is worth to be specially mentioned. A good example of self-developing and self-organizing systems is the description of "personal meaning theory of thinking" suggested in 1960s–1980s by Tikhomirov (Tikhomirov, 1969; Tikhomirov, Klochko, 1980). Dynamics and hierarchies of personal meanings within affective cognitive structures have been thoroughly investigated since that: see the neighboring papers in the current issue of the journal.

This new perspective on how science can be organized in the near and distant future has declared itself in the form of the aforementioned contradictions. The transdisciplinary approach matures within the interdisciplinary discourse and an orientation toward the differentiation of scientific disciplines; their closed nature, which has been the condition for maintaining sovereignty, changes with an orientation toward openness. Indeed, openness has always been present in the monodiscipline; this openness was for a while latent as it has not been noticed by the methodologists who consider the process of science development as self-organizing and who are focused on cognizing inner mechanisms of science development (scientific revolutions, paradigm changes, and so forth). Cross-fertilization (L. von Bertalanffy), the mutual fertilization of sciences in the process of their interaction, has not yet been perceived as the source of science development. That is why interdisciplinarity is still considered by many scientists in an oversimplified manner. In this case, as French professor Edgar Morin, president of the Association for Complex Thinking, writes, "[interdisciplinarity] may mean only and simply that dif-

ferent disciplines sit around the table just as different nations gather in the United Nations exclusively to claim their own national rights and sovereignty as related to the infringements of their neighbor" (quoted in Knyazeva, 2001, p. 5). Quite often our conferences devoted to discussions of complex phenomena, including cognition and its evolution, are, in fact, reminiscent of UN sessions.

"If we want to trace the course of studying these complex phenomena in the history of science," writes Knyazeva (2001, p. 3), "then the history of science presents itself as a history of the merging of scientific disciplines and of the breaking of the borders between them, the transdisciplinary transfer of notions and cognitive schemes, the forming of hybrid disciplines." As Morin mentions, "When the official history of science is the history of disciplinarity, the other history of science related to the first one and inseparable from it is the history of inter-poly-transdisciplinarity" (quoted in Knyazeva, 2001, p. 3).

Let us demonstrate how L.S. Vygotsky, the Mozart of psychology, who has never been understood in "the official history of science" despite his worldwide recognition as the forerunner of cognitive science, is described in "the unofficial" history of psychology.

In the work "Consciousness as a Problem in the Psychology of Behaviour" (1925) Vygotsky writes that "the work of each organ … is not something static but is only the function of the state of the whole organism. The nervous system works as a whole—this (Sherrington's) formula must be understood as the ground for the theory of the structure of behaviour" (Vygotsky, 1982, p. 81). Charles Sherrington introduced the notion of synergy into scientific discourse, and the founders of the general theory of self-organization (synergetics) give credit to him (Haken, 2001). Drawing on Sherrington's formula, Vygotsky comes, on the one hand, to the idea of the selective interaction of the system with the environment (the idea of the "funnel," to which scientists regularly refer) and, on the other hand, to the formulation of one of the major ideas in the current theory of self-organization: the weak interaction that is able to determine the further development of a system approaching the bifurcation point. Vygotsky shows that "one can easily imagine how not-significant-by-themselves reactions and even hardly noticeable [ones] can turn out to be the guiding ones depending on the current conditions at the 'collision point' that they enter" (Vygotsky, 1982, p. 87).

Vygotsky referred again two years later in the work "The Historical Meaning of the Crisis in Psychology" to the idea of the funnel through which "Heraclitus's flux," the chaos of the external, is sorted out and restricted. He wrote:

> The psyche selects stable points of reality among the overall movement. It is the island of security in Heraclitus's flux. It is the organ of selection, the sieve screening the world and transforming it in such a way that makes it possible to act. In this is its positive role—not in reflection (the nonpsychic reflect as well; the thermometer is more precise than sensation) but in not always reflecting right—that is, subjectively distorting reality for the benefit of an organism. (Vygotsky, 1982, p. 347)

This is the origin of the idea of the selective interaction of a person with the environment, the idea of self-selection. People do not simply live in the environment and exchange information, matter, and energy, as is characteristic of any open

system. They not only change the environment, returning what has been processed, but also create their own multidimensional world on the basis of the infinite-in-its-opportunities and thus amorphous, indifferent "environment."

Vygotsky saw the function, the mission, of the psyche not in its calling for reflection but in its "subjectively distorting" objective reality for the benefit of the person. What is not creating that which it is impossible to act on if not a real way out to the process of the creation of multidimensional reality? All these constructions by Vygotsky, growing out of interdisciplinary interaction, in fact moved on to the transdisciplinary level, covering attainments in psychology as well as in the physiology of that time, and although fallen out of the historical-psychological analysis conducted by the "official" history of science, they still remain as a (not quite conscious) ideal for the cognitive science of our time. The mechanism of selective interaction is the transdisciplinary product of interdisciplinary interaction. That is why we can agree that "transdisciplinarity is a way of broadening the scientific outlook by implying consideration of some phenomenon unrestricted by the frameworks of some scientific discipline" (Transdisciplinarnost', n.d.)

Let us move on to another example of transdisciplinary interaction. When future Nobel Prize winners James Watson and Francis Crick tried to integrate physical-chemical and biological knowledge available about DNA, at first glance everything seemed simple:

> Watson and Crick analyzed data of the x-rayed structural DNA, compared it with the results of chemical studies of the nucleotide bases ratio in DNA (Chargaff's rules) and applied Linus Pauling's idea about the possibility of the existence of spiral polymers of proteins. As a result they were able to propose a hypothesis about the DNA structure according to which DNA was represented as being comprised of the two long polynucleotides connected by hydrogen bonds and twisted around each other. (Musskii, n.d.)

The "official" history of science would record the fact that Crick and Watson completed the development of the DNA model in 1953, and 9 years later together with Maurice Wilkins they received the Nobel Prize in physiology and medicine for "discoveries in the field of molecular structures of nucleic acids and their importance for information transfer in living systems." The history of science as the history of inter-poly-transdisciplinarity would record the discovery of the mechanism of selective interaction that is at the core of life itself—complementary interaction. "Our structure—wrote Watson and Crick—is comprised of two chains, each of the two is complementary to the other one" (Musskii, n.d.). Complementarity had come to be understood as the mutual correspondence in the chemical structure of macromolecules that ensures their interaction. In Vygotsky's theory, the selective interaction of a person with the environment can be considered as a spatial-complementary interaction at the base of which is correspondence manifested through meanings—people live in "fields of meanings." We have been working with these fields for a comparatively long time (Klochko, 2005), and this experience brings us to the conclusion that it is not by chance that Crick refers to the category of meaning, asserting that some of the nucleotide triplets in the DNA model have meaning (correspond to amino acids) while others do not.

These conceptions of Crick and Watson and of Vygotsky highlight not-incidental coincidences that in transdisciplinary perspective point at some significant regularities characteristic of any open system whether living or not. Today evidence is not necessary to prove the thesis that all open systems (including systems that are co-dimensional to a person) ensure their sustainable existence through the exchange of energy, matter, and information with the environment. It is more difficult to accept the thought that specific organs of selection (the complexity of the structure of which is adequate for the complexity of the system they are representative of, but the way of functioning of which has something in common and is invariant) are characteristic of all the open systems comprising the universe (Galazhinsky & Klochko, 2009; Klochko, 2010; Klochko & Galazhinsky, 2009).

Possibly, here we are confronting the fundamental principle of being adequate for the whole universe; its semantics is invariant in its basis for any system. This is the principle of directed, selective interaction, which is the core of self-organization and its brightest manifestation as a basic foundation of self-development for both the universe and its systems. Active waiting is the form of a system's going out into the space of the surrounding world and its distortion; but its own "subjectivity," meaningful "markers" of the world, is what is characteristic of open systems at different levels. Consequently, such notions as waiting, the subjective distortion of reality, meaning, belief, hope, love, and other "existentials" attributed exclusively to a person are predetermined by the very principles of the universe's organization, and at the lowest levels of system development they exist in their potential, not-yet-developed form. Particularly in such a form they introduce themselves to the "natural scientists," and it is obvious that not all of them can see what they would develop into at the higher stages of organization. It seems that science should change its strategy and start moving on to cognizing the lowest forms, drawing from what is already known from studies of a person as the representative of the highest form of life.

In discussing a problem as serious (and as increasingly relevant) as the synthesis of humanitarian and natural sciences, one must understand that the focus of discussion is indeed the synthesis of the two historically molded cultures of thinking. The gap between these cultures not only hinders the building of a holistic worldview but also significantly limits the development of scientific knowledge itself. Psychology as a science has its own specific features: basically, contrasting the two cultures of thinking, determining ways of posing and solving scientific problems, and interpreting obtained data. Nevertheless, if one considers the process of the development of science not retrospectively but transspectively (Klochko, 2005), then one can recognize signs of the convergence of the two cultures, which has lately acquired the character of a rather sustained tendency. Analysis of the experience of intrascientific synthesis can be helpful for identifying the mechanisms and tendencies of the movement of inter- and meta-disciplinary synthesis.

The most interesting aspect of what transspective analysis has shown turns out to be related to the specific features of the interaction of the two cultures of thinking within one science, which is trying to preserve its completeness even though it is being haunted by a "permanent crisis." The intensity of this interaction is growing along with the ability of science to identify and to make the subject of research systems with growing complexity. Classical science could

with one-dimensional logic identify a simple system–the system of psychological phenomena inside of self-contained consciousness. The origin of the opposition of humanitarian and natural-scientific thinking is found to the fullest extent in nonclassical science based on binary logic. This logic has manifested itself in particular in the singling out of humanitarian psychology ("psychology of a person") and natural-scientific psychology ("psychology of the psyche"). Initially these two psychologies tended toward synthesis; their merger was initiated from the part of the natural-scientific paradigm inside of which at that time was proposed the principle of additivity based on the philosophical consideration of complementary (additive) interaction.

Today, multidimensional thinking has been developed, and a unique situation occurs in science as it undergoes the process of transition to the ideals of post-nonclassical rationality. The incentive for integration was initiated by the part of humanitarian sciences that suddenly realized that the systems under consideration are much more complex than those with which the natural sciences work, and the descriptive language for these systems is very simple. Integration also results from the absence of the logical and mathematical procedures necessary for studying multidimensional phenomena. In the end, if natural sciences have enriched humanitarian sciences with knowledge about complementary (additive) interaction, then humanitarian sciences in their turn have enriched all the other sciences with knowledge about an even deeper interaction, complimentary (generating multidimensionality) interaction (L. Gumilev). Having accepted complementary interactions (from Latin *complementum*, addition) at the stage of the transition to nonclassical ideals of rationality, today, at the stage of mastering the ideals of post-nonclassical rationality, we have to admit the existence of complimentary interactions (from French *compliment*). Complimentarity, according to L. Gumilev, who used both terms, is the act of understanding that goes beyond the borders of the empirical experience of the given culture to the basis for cultural symbiosis, the intrusion of one culture into the reality of another one, and generates a new reality.

This may be the meaning of the transdisciplinary approach–to generate new knowledge (and new thinking) beyond the borders of the established cultures of scientific thinking. The fact that the notions *complementarity* and *complimentarity* are used in almost all scientific fields is an indirect sign of the synthesis of humanitarian and natural sciences. In 2007 the number of references to these two related notions and their analogues in Runet was a thousand diverse references; now this number is many times higher. The impression is that the sciences, growing in their complexity, are becoming capable of finding the way back to their common, original beginning, which is the true basis for their integration. In other words, moving on their own, different sciences, through transdisciplinary interaction, are capable of reaching universal principles that to the same extent can be applied to self-developing systems of any complexity, including such principles as the ones that explain the mechanism of the growing complexity of system organization as a way toward the sustained existence of open systems in space and time.

However, the problem of consciousness is not resolved with the help of simple forms of thinking. Psychologists are amused by this fact almost in the same manner as physicists were at one time surprised by the fact that the result of physical study

depends on the position of the observer. Behind the problem of consciousness is hidden the problem of the reality of being. "The bare physical stimulus of the light is not a complete reality," wrote Vygotsky (1983, p. 73). People's environment is not a physical environment, a "clean objectivity," for them. "There is no bare, unsocial, immediate communication of a person with the world" (p. 63).

But what mediates this communication with the world? It is mediated by the construction of the "third reality" between the world of "clean objectivity" existing beyond and independent of people, this real "thing in itself," and their subjective world, which is also called their "inner world." It is not possible to locate this "third reality" on one of the poles: it can be reduced neither to subjective nor to objective reality. It is perceived by people as something external to them, their inner personal life space. This reality is sensual and pretersensual at the same time—that is, it includes system formations that do not influence the organs of the senses and thus continue to be invisible. Finally, it can be reduced neither to spirit nor to matter; it represents a true (system) unity of these two "opposites." The subjective (spirit) is some kind of marker, which has to format objective reality in advance so that it makes sense to a person; it distorts objective reality in some way, having marked in it that which makes sense, has meaning and value for a person. Meanings appear at the locations of the meeting of matter and spirit; they indicate that in these places in particular a correspondence exists between what a person needs and what in the world responds to their request. That which makes personal meanings, as introduced by Tikhomirov (1969), enter into consciousness.

A person is a system of interactions generating meanings and values that are the grounds for directed acts of behavior. Then what is the essence of the "drama" that was hinted at in the works of Vygotsky—the drama of experiencing—to which people are doomed because of their special (system) organization? With this drama in particular are connected all the difficulties connected with the attempt to explain the nature of the selectivity and sensibility of human consciousness, behavior, and activity. This is how the drama is viewed from the position of system anthropological psychology.

People always see some piece of the world, some part of it, a segment, or a "situation." They never see themselves in this world, although they are present in it, as this *world of a person* itself is the continuation of a person, of the *life space* attributed to him or her. People do not know their own "dimensions," and, by interacting with what is perceived as an opposed-to-them objective reality, they are interacting with themselves invisibly present in this reality by force. A person is represented in reality not by the physical parameters of the objective content of reality but by the special dimensions of objects constituting the situation and by the "clean objectivity" that singles them out of the infinite and exists in itself and for itself. People cannot and do not have the appropriate means and even the right to see themselves in the world and as a constituent part of the world. Only through thinking can they come to an understanding of the co-dimensionality of what appears to them as objective reality, of themselves. In real life people follow meanings the purpose of which is to make apparent what is relevant for them here and now. This selection is so natural for us that we miss out on the complexity of the selection mechanism and use only its results. However, if this process were different, there would be neither consciousness nor self-consciousness. Animals have a much more simple

organization than people: they live in the world and do not single themselves out of it. But they also do not create this world, and if they change it, it is only because of existing in it.

The evolutionary growth of the complexity of the system organization of a person is revealed in the ability to generate "matched," sensual-pretersensual reality; the only purpose of this ability is to ensure for people an opportunity to rather clearly separate I from not-I, to see the world separately from themselves, and to experience the effect of being present in the world, which is the major feature of consciousness. Only in this case can people feel themselves as subjects who cognize and create the world, become aware of it, and experience it. This gap (not to see themselves in the world but to see the world separated from themselves) is the reason for the exceptional character of human beings. Reconstructing the world is possible only though reconstructing oneself; cognizing the world one cannot avoid cognizing oneself. "Golgotha of the human spirit"—this is how Hegel defined the work of one's mind, which has to always cognize this world through the prism of one's own subjectivity but meanwhile must struggle to determine the truth by driving oneself out of the products of cognition for the sake of revealing the way something "really is." For this reason determining the truth is not a self-contained, immediate outcome of cognition but is a process that is accompanied by an on-going dialogue of people with themselves and significant others. This dialogue is invisibly present in the encounters of people (as subjects of activity) with objects that have been "humanized"—that is, encounters in which people are already represented by their special (system) qualities: values and meanings. Thus, everything that appears to us, everything that we see, hear, and think about, appears to us only because it has a meaning and value to us.

Consciousness is the ability of people to see the world separated from themselves but to see only that part of the world that corresponds to them as people; their sustained being depends on their ability to detect in the world that which corresponds to their needs and possibilities. Therefore, any situation is the projection of a person into objective reality because a situation starts to be not "a thing in itself" but the world with its objective content experienced as reality and actuality. A person is an open system and can be considered as a special spatial-time organization. A person does not simply live in an environment exchanging information, matter, and energy and having it returned processed and transformed as exchange products. People create their own multidimensional worlds on the basis of the "environment," which is infinite in its opportunities and thus amorphous, indifferent.

Knowledge about the pretersensual (system) qualities of objects, in which the "transitive" (between spirit and matter) form of human existence exists, is the innermost, the most mysterious psychological knowledge. If this knowledge moves to the level of thinking and understanding, then scientists will have acquired a new way of thinking and will, as well, be allowed to see themselves, other people, and their profession from a new (and rather unusual) perspective. There is no dispute about the way their professional competence itself would change. One can distinguish competence based on reason and another competence based on mind. To move from one to another, following Hegel's terminology, means moving from one thinking to another: reason stops before differentiating between I and not-I,

and mind (theoretical thinking) "grasps their unity." It also means that scientists' consciousness, faultlessly identifying the border between I and all the rest (not-I), would go up to the level at which the line, set up by reason, dividing I and not-I, matter and spirit, the subjective and the objective, the internal and the external, the psychic and the physical would become indistinguishable. It is not by chance that these dual forms have been called "opposites." Emotions are a special form in which meanings and values exist for a person. Even now a question that poses great difficulty for psychologists is how objects, particularly those objects that we need, "get imposed" on our mind, while others, which influence the organs of sense to the same extent, do not "get imposed." However, the scheme is still alive according to which people "see everything" and afterward select out of "this everything" what has an immediate relevance to them. A person cannot "see everything": "An eye which would see everything would see nothing because of that; consciousness that would be aware of everything would be aware of nothing, and self-consciousness if it would be aware of everything would be aware of nothing" (Vygotsky, 1982, p. 347).

The paradigm of reflection for the most part does not take into account the role of culture for those mediators (adults, educators) who stand between a child and a world of culture that influences the emergence of the multidimensional world of a person as a value-meaning field, the "open space of life." This paradigm dictates a view of the world as a "space for life" that has to be "assimilated" through acquisition of the knowledge and "experience" accumulated by humankind in general, including abilities, skills, and ways of thinking that one has to be able to reproduce. Given this requirement, it becomes increasingly important to evaluate the moves that are occurring in the paradigm of the dynamics of science. If we pay attention to the text of the "World Declaration on Higher Education for the Twenty-First Century: Vision and Action," adopted by the participants in the International Conference on Higher Education in 1998 in Paris, we will notice among the recommendations the necessity of encouraging the development of transdisciplinary programs in the educational process and of training future professionals by implementing the transdisciplinary approach for solving complex problems of nature and society (UNESCO, 1998). Particularly here there opens a new subject and problem field for the contemporary theory of education and those sciences that, having relevance for the study of cognition, ensure the emergence of cognitive science.

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