

## **THE PHENOMENON OF INTERDISCIPLINARITY: COGNITIVE SCIENCE**

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*The phenomenon of interdisciplinarity is considered as a factor of formation of post-non-classical science at the example of cognitive science. The structure and nature of the relationships within cognitive science are analysed at various stages of its development: multidisciplinary, interdisciplinary, on the way to transdisciplinarity. The role of philosophy in the development of cognitive science as a complex system is revealed.*

*Keywords: interdisciplinary, transdisciplinary, cognitive science, post-non-classical science.*

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### **ФЕНОМЕН МЕЖДИСЦИПЛИНАРНОСТИ: КОГНИТИВНАЯ НАУКА**

*В статье рассматривается феномен междисциплинарности как фактор становления науки постнеклассического типа на примере когнитивной науки. Проанализированы структура и характер связей внутри когнитивной науки на разных стадиях ее развития: мультидисциплинарной, междисциплинарной, в период становления трансдисциплинарной. Выявлена роль философии в развитии когнитивной науки как сложной системы.*

*Ключевые слова: междисциплинарность, трансдисциплинарность, когнитивная наука, постнеклассическая наука.*

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### **ФЕНОМЕН МІЖДИСЦИПІНАРНОСТІ: КОГНІТИВНА НАУКА**

*У статті розглядається феномен міждисциплінарності як фактор становлення науки постнекласичного типу на прикладі когнітивної науки. Проаналізовано структуру і характер зв'язків усередині когнітивної науки на різних стадіях її розвитку: мультидисциплінарній, міждисциплінарній, в період становлення трансдисциплінарної. Виявлено роль філософії в розвитку когнітивної науки як складної системи.*

*Ключові слова: міждисциплінарність, трансдисциплінарність, когнітивна наука, постнекласична наука.*

Cognitive science is a new rapidly developing modern complex area of research. Formed in the United States, it has gained a reputation in countries of Eastern Europe, including Russia and Ukraine during last two decades. It is evidenced, for example, by regularity of conferences on cognitive science in these countries, by creation of "Interregional Association for Cognitive Studies" in Russia in 2006, "The Center for Cognitive and Semiotic Research" in Ukraine in 2012.

Cognitive science is an interdisciplinary field, the complex of sciences studying cognition and higher mental processes through the use of common information-theoretic models, similar methodological principles. Despite the existence of different ways of combining cognitive sciences in "federation" (e.g., [3, p.18], [11, p.143], [4, p.7]), the most common are the following: philosophy (epistemology, methodology of science), psychology, artificial

intelligence, neuroscience, linguistics and anthropology. The connections between these sciences may have different strength and character.

Cognitive science is an important subject of philosophical analysis, in particular for the philosophy of science, because of its interdisciplinary nature (since interdisciplinary influence, according to Stepin, is one of the factors contributing to the evolution of scientific knowledge, and sometimes even provoking scientific revolution [9, p.443]).

The aim of the present paper is to identify the nature of the relationships between sciences belonging to a subset of cognitive, reveal their common origin and indicate the role of philosophy within cognitive science.

Let us consider the first question.

Currently, there are several classifications of complexly organised Sciences. In this case, it is advisable to use a ranking of complex sciences depending on the degree of ordering of internal interdisciplinary links proposed B.Nicolescu, the President of The International Center for Transdisciplinary Research, founded in 1987 in France [12], [10].

Multidisciplinary or polydisciplinary science doesn't assume the integration of disciplines, while the object is being studied within several disciplines from different sidessimultaneously. Any topic studied within a single discipline can be enriched through neighboring disciplines without changing the ultimate goal of the research, methodology and theoretical assumptions of each discipline also remain unchanged. In other words, in this case, each member of a multidisciplinary team of scientists will conduct research within their own discipline, according to the rules and regulations of their community in pursuit of some internal disciplinary aims. Final result will be presented as series of separate reports with no common base [12, p.22], [10, p.6].

Interdisciplinary science is organized mainly hierarchically, its purpose is to overcome the limitations of disciplines and their excessive specialization. The research within a single discipline depend on the practice or values of another, of a higher level. For example, the medicine becomes interdisciplinary, setting specific goals for biology, chemistry and psychology. In this case we are borrowing methods of one discipline from another, we have the integration of different theoretical assumptions, the unity of some of the concepts, terms. In this case, despite the break of boundaries of the former discipline, its ultimate goals remain unchanged. Often theoretical knowledge of one discipline and technological advances of another are combined within an interdisciplinary science, as well as new branches or disciplines emerge.

Transdisciplinary science covers all that is inside every single discipline, between them and outside of them simultaneously, presenting the subject of study holistically. The aim of such science is to comprehend the world as a whole. A formalized description of the basis of a unified methodology of transdisciplinary science has been developed by B.Nicolescu [12, p. 24]. The researcher suggested that a common methodology is based on three axioms: ontological, logical, and complex. According to the ontological axiom, the object and the subject have several levels of reality in nature, society, and in our knowledge of nature and society. The "level of reality" is a set of systems that are invariant under certain fundamental laws (for example, objects of quantum physics and the macrocosm are from different levels of reality).

According to logical axiom, the transition from one level of reality to another is provided by the logic of the included middle, replacing the law of excluded middle of Aristotle's logic. Due to the use of this logic quantum and the macroscopic world, wave and corpuscle, continuity and discontinuity, reversibility and irreversibility of time can coexist [12, p. 29]. Included middle allows to connect transdisciplinary subject and object in the process of cognition. The basis for the application of this logic is the fact that everything that exists is related through an association

to another, forming "transversals" arising due to the context and situation [5, p. 30]. According to the complex axiom, the common structure of levels of reality is complex.

Other researches define transdisciplinarity in a slightly different way. For example, according to E.Knyazeva, transdisciplinary science in a broad sense supposes the unity of knowledge within specific disciplines and beyond, transdisciplinarity in a narrow sense means "... the integration of various forms and methods of research, including special methods of scientific cognition, to solve scientific problems "[6, p.194].

Assuming that the types of science in the above classification inherit each other in the course of the evolution of scientific knowledge, let us classify cognitive science. For this purpose we shall define what disciplines lie in its basis, how the connections between them have been established, define the nature and intensity of these connections, and what structure cognitive science acquired in the end.

The "cognitive turn" in science took place in the second half of the twentieth century. It is difficult to call the exact date of forming of cognitive science, because the idea of combining disciplines such as psychology, computer science, neuroscience, linguistics emerged in the 1950s, while its main institutions – the Cognitive Science Society and the Cognitive Science journal were created only 20 years later. During this time and later interdisciplinary relations have been changing, and one or another discipline has been keeping the leading role. If we define this process of merging as a "unified interdisciplinary approach", under which "... there was the opportunity to share ideas, models and other scientific results of researchers working with different methods on cognitive issues" [4, p.6], then at the beginning of its formation cognitive science could be classified as a multidisciplinary, whereas in the last quarter of the XX century it transformed into interdisciplinary.

As an example of multidisciplinary influences can be named: the creation of neural networks, transformational grammar, penetration into the psychology of the provisions of the statistical theory of communication, through which "... an understanding of man as a communication channel with limited capacity" [1, p.96] emerged. For twenty years mutual enrichment of disciplines has taken larger scale, and cognitive science evolved into a multidisciplinary, with uniform problems and some common methodological principles. At this time, the cybernetic metaphor "man is a machine" was replaced by the computer: "the brain is a computer system", a new method for the study of consciousness was suggested – computer simulation. At this time a lot of discoveries in neuroscience were made that gave the actual status to cognitive science due to the possibility of experimental verification of research (discovery of the functional asymmetry of the hemispheres of the human brain and the two types of cognitive thinking by the American neurophysiologist R.W.Sperry and his colleagues) [4, p.7].

This period is characterised by B.Velichkovsky as "consensus of the 1970s", when inside the disciplines included in cognitive science unified vision of the theoretical foundations, methods and models of research have been formed [1, p.117]. Thus, analyzing the ideas of cognitive psychology of the 1970s, we can clearly trace the primacy of computer science in interdisciplinary hierarchy of cognitive science at that time. B.Velichkovsky distinguishes the following principles of the paradigm of early cognitive psychology: the priority of knowledge and rational cognition over behavior, habits and affect; use of computer metaphor; the idea of sequential processing of information; emphasis on formal modeling instead of studying brain mechanisms [1, p.118]. Linguistics at this time was being developed in close connection with the philosophy (analytical branch), where the study of the theory of reference had the priority, the task of philosophy was seen in revealing the deep grammar, general formal structure of ordinary language. The language at the same time was considered in cognitive science as a sign system

for the categorization, retrieval and storage of information, information was a name for meaning [7, p. 39].

Thus the basic ideas of computer component of cognitive community, or rather, artificial intelligence (which was isolated as a separate field of research in the middle of the twentieth century) determined the vector of development of other disciplines in the "early" period of cognitive science, when it has become interdisciplinary.

One of the features of interdisciplinary science is the emergence of new trends and disciplines inside it. Report on the state of cognitive science up to the 1978, created by leading experts in this field, helps us to identify what new areas of research were formed at an early stage of development of cognitive science [11, p. 143]. So, at the intersection of linguistics and computer science mathematical linguistics has been formed, and psychology with linguistics has given rise to such a branch as psycholinguistics.

Ironically, philosophy had quite a modest role in this report: it was connected directly only to psychology and linguistics. The existence of strong connections between these sciences is undoubted, at the same time lack of connection between philosophy and computer science is surprising, because the development of artificial intelligence (as a part of computer science), has put a lot of philosophical questions: ontological, epistemological, ethical.

In the 80s-90s of the twentieth century the institutes of cognitive science have developed sufficiently, and the scientific community there appeared some researchers, who could be called "cognitivists". For example, one of the key idea of the cognitive approach of this period – the idea of modularity of consciousness – was expressed by philosopher, cognitive scientist J. Fodor. Combining revised linguistic theory of N. Chomsky based on his philosophical ideas and some postulates of phrenology, Fodor has formulated a new approach to the understanding of cognitive architecture. As a methodological basis J. Fodor suggested the use of "methodological solipsism" – the principle that the study of cognitive processes is carried beyond relationships to other objects, the events of the outside world.

Another view (connectionism) – the idea of parallel processing of information – was formulated, formalised and implemented by psychologists and experts in the field of computer science D. Rumelhart and J. McClelland. In such a way the relationship between cognitive disciplines (philosophy, linguistics, psychology, neurophysiology, artificial intelligence) have been increasingly strengthened, a typical for interdisciplinary sciences synthesis of theoretical knowledge and technological achievements appeared, circulation of terms between disciplines began. Thus, in psychology they began to use anatomical-physiological terms [1, p. 141]. In addition, in this period the influence of neuropsychology strengthened: an interest for neuropsychological data increased, they began to use syndromic analysis, that remains relevant within cognitive science till the present days.

Connectionist ideas about consciousness are strikingly different from those in the information (classical) approach, they correspond to different "levels of reality." If the classical approach assumes that mental processes are comparable with programs "running" on your computer (brain), the connectionist model is as follows: mental processes are large-scale dynamic neural networks. Connectionism refuses symbolic approach and the possibility of decomposition of the cognitive system into components and deducing rules of its functioning, offering a model of holistic perception.

Currently within cognitive science it is proposed to use pluralistic approach as an alternative (by virtue of the irreducibility of different areas of knowledge to each other, specialization of subjects of scientific activity) that outlines a tendency of transition to transdisciplinary science (by Nicolescu) or post-non-classical science (by Stepin), implying the coexistence of different disciplinary picture of the world or different levels of reality of the

unified scientific picture of the world, "... the unity in diversity of different disciplinary ontologies" [9, p. 404]. Thus, B.Velichkovsky associates progress not only in psychology but also in the whole cognitive science with "... pluralism, broad vision of a situation, admitting the existence of many qualitatively different "entities" that do not form an absolute unity" [2, p. 335].

Another feature of the transforming into a new type of science is the awareness of the fact that the objects of study are complex historically developing systems, so that paradigms and world pictures of different disciplines have to be combined. This "awareness" came into cognitive science, for example, with the appearance of cognitive-discursive approach to language in e linguistics, proclaiming the synthesis of cognition and communication, involving the "stepping out" of linguistics on communication with other sciences, turn to the anthropocentrism [8, p.230]. In psychology, this process involves an appeal to the cultural-historical analysis, the study of the mind and consciousness in close connection with the language, highlighting as priorities the study of learning, understanding, problem solving, with reference to the theory of "bodily grounding of knowledge" [2, pp.330-336]. Now consciousness is being studied not in isolation but as the brain-body-external environmentsystem. At the same time cognitive orientation of research appears within other sciences: economics, political science, sociology, etc. In addition, as is typical for transdisciplinary science, new hybrid fields of research continue to emerge [4, p.8].

The concept of "transdisciplinary science" of B.Nicolescu, which is an idealized view of the science of the future, has much in common with the concept of "post-non-classical science" of V.S.Stepin. The two researchers have noted a tendency for interdisciplinary integration, using pluralistic world pictures (levels of reality) and common philosophical foundations. Also Stepin notes that post-non-classical science, based on the principles of evolution and systematic approach, is a distant prospect. The characteristics of the near future of science is a combination of disciplinary and interdisciplinary research, strengthening backward and forward connections between them, a blurring of boundaries, the adoption of a common scientific picture of the world as a global research program [9, p.404]. If the first three features characterise cognitive science in its modern state, any global unidirectional development of science can't be seen yet. Just philosophy, the traditional role of which is transcendental reflection, should contribute to finding a common base and direction for development of cognitive science, the more so within the disciplines included in cognitive science, this issue has been neglected. It means that the role of philosophy, according to Stepin, consists not only in the selection and formulation of the foundations of science (scientific world, ideals and norms of scientific cognition, the philosophical foundations), but also in the allocation of interdisciplinary components, that builds connections between disciplines, which allows us to transfer ideas and methods, elements of disciplinary ontologies, philosophical foundations [9, p.445]. Besides the problem of interdisciplinarity or transdisciplinarity philosophy, as part of cognitive science, should continue comprehension of problems of the nature of consciousness, connection of consciousness and brain.

Thus, cognitive science, combining humanities and natural sciences with various schools and trends, different approaches and models, is being developed as a complex open system. At present this science has interdisciplinary character, and to grow into transdisciplinary it is necessary to comprehend its interdisciplinary component, allocate general philosophical grounds. Involvement of philosophy allows not only consider each discipline separately, but also between them, because consciousness, intelligence, language, communication and culture are inextricably linked. Within the framework of cognitive science post-non-classical type of scientific rationality is being formed due to which it is possible to correlate knowledge about cognitive processes not

only with interdisciplinary activities, but also with social values and goals [9, p.445]. The adoption of transdisciplinary methodology, that assumes existence of multiple levels of description, pluralistic approach and the use of logic of included middle, will allow to systemise theoretical knowledge, find general direction of the development of cognitive science.

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