Proliferation of Neuroscientific Knowledge in Pedagogy and Education

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Abstract – The article deals with the process of proliferation of ideas and technologies related to the development of neuroscience in pedagogy and education. The levels and directions of this process are determined as well as the risks associated with the vulnerability of human nature in the spheres of socio-cultural reproduction.

Keywords – neuro-education, neuro-pedagogy, neurotechnology, neuroethics, humanitarian paradigm, technocratic paradigm

I. INTRODUCTION

The rapid development of neuroscience in the last three decades has significantly changed the disciplinary profile of social and humanitarian knowledge and practices. Pedagogy and the education system are not exception. The interest in using data from neuroscience research in pedagogy is understandable: knowledge about brain functioning and nervous system allows solving pedagogical problems more effectively. In Russian science, for example, the foundations of such an approach were written by L.S. Vygotsky and continued successfully in the neuropsychological school A.R. Luriya and his followers. Therefore when in the second half of the 20th century new technical means (CT, MRI, PET) expanded the possibilities of studying brain activity in international and national, pedagogy, this interest is formed in the appropriate areas: neurodidactic and neuropedagogy. In the 21st century new trends responding to the modern spirit of techno-science were transformed into a socio-economic project called “neuro-education” which implies the introduction of neurotechnologies and neuroscience into the educational system.

Such significant changes in the sphere of socio-cultural reproduction immediately became the subject of ethical and humanitarian discussions. On the one hand, neurotechnology is associated with “creating a new class of global competitive technologies necessary for the development of new markets, products, services including those ones aimed at increasing the duration and quality of life” [1]. Neuro-education is a necessary component of such process. On the other hand, there is a reason to believe that under the scientific and technological progress very dubious educational projects in the spirit of neuro, info, and techno-anti-utopias are being implemented in terms of justice and humanism [2–5]. Both increasing the learning process efficiency and expanding the educational opportunities of each individual are connected with neuroscience and pedagogy [6–8] and dehumanizing of education system, turning a person into a “programmed” consumer and / or performer [2, 5, 9].

II. PROBLEM STATEMENT

The research reveals 1) the content uncertainty of the terms “neuro-education” and “neuro-pedagogy”, 2) an incorrect performance of the neuro-research results in the public sphere. This leads to incorrect performance about opportunities and perspectives of using neuro-scientific knowledge and neurotechnologies in the educational sphere manipulating fears, prejudices, expectations and people’ needs. In addition, the high axiological significance of transformations in the educational sphere inevitably leads to the question about the boundaries for penetrating neurotechnologies into the process of socio-cultural reproduction: where does dehumanization begin and appear changes in human condition/nature?

Research purpose

Within the framework of research challenge the following tasks are set: 1) to identify the semantic content of the concepts “neuro-education” and “neuro-pedagogy” in modern discourse (scientific, scientific popular, publicistic); 2) to identify potentially risky zones for penetrating neurotechnologies into the process of socio-cultural reproduction.

III. METHODS AND MATERIALS

In order to solve the first question the authors use content analysis with the keywords “neuro-pedagogy”, “neurodidactics”, “neuro-education”. Content levels: scientific, scientific popular, publicistic. To identify the semantic content hermeneutic methodology is used. The second task required a critical analysis for the content of ideas and social practices being developed and implemented in the semiotic area. The critical analysis is based on the following ideas: 1) about a person as a complex bio-socio-spiritual and self-developing system 2) about education as a process of socio-cultural expanded reproduction where individual and social needs, interests and opportunities are combined.

IV. NEURO-PEDAGOGY AND NEURO-EDUCATION

In national science the term neuro-pedagogy has been entrenched in relation to the applied field of pedagogy, based on the theoretical conclusions of neurophysiology and
different psychological science here is "educational neuroscience" which also tries to show how new knowledge about the mechanisms of brain functioning can be applied in the educational process to increase its effectiveness. Interest in the neuro-physiological basics of learning processes in many countries has received institutional and financial support. For example, in the United States, the Center for Educational Research and Innovation (CERI) of the Organization for Economic Cooperation and Development (OECD) implements the international project Brain and Learning which brings together scientists from thirty countries of the world. In Russia the "first platform of neuro-pedagogy" was the Institute of Cognitive Neuroscience (ICN) at the Modern Humanitarian Academy [10]. Much attention is paid to neuroscience in education in France, Canada [11], Great Britain [12], and USA [8].

The expanding sphere of knowledge began to claim independent disciplinary status. Neuro-pedagogy is now understood as an integrated educational system of upbringing and teaching based on the neuro-scientific achievements, "the highest modern stage of classical pedagogy" [7, p. 9]. It opens the logic for development of explanatory ideas which L. Vygotsky suggested in his work on the methodology of psychology [13]. The explanatory idea falls into the sphere of the disciplinary fight for domination. This fight is accompanied by ideological transformations. Two of them are already obvious.

First there is a reduction of ideas about a person as a holistic multi-level, self-developing system (such an understanding is the achievement of pedagogy of the XIX - XX centuries) to a complex neural network that needs to be trained. Explicitly this is not denoted by researchers but the reduction methodology reveals itself. For example in the article "Neuro-pedagogy: a new branch of scientific knowledge" (2016) the authors, specialists in the field of pedagogy and psychology declare: "neuro-pedagogy is designed to solve fully and completely all the tasks with pedagogy and its related sciences" [7, p. 9]. It means that the pedagogical knowledge system, reflecting the most complex contradictory human nature and its development in ontogenesis can be reduced to knowledge about neural correlates for pedagogically significant processes.

The dubious nature of such logic determines the debatable question about the relationship between neuroscience and pedagogy. A number of international and national researchers point to incorrect extrapolation of knowledge from the field of neurophysiology and neuropsychology to pedagogy. They see in this the reasons for the formation of "neuro-myths" - simplified images of pedagogically significant processes leading not to understanding but to the formation of standard pedagogical practices [14, 15]. Even in the scientific discourse there is a substantial uncertainty of the concepts for "neurodidactics", "neuro-pedagogy" as well as the banality of the proposed principles of neuro-didactics [16]. The need for verification of interdisciplinary research in the field of neuroscience in terms of the possibilities of their actual use in education is rightly emphasized [12]. It is not by chance that the scientific community itself emphasizes the need to separate neuro-pedagogy as a science from quackery which develops around the term "neuro-education" [11, 12, 14].

The second ideologically significant transformation is the identification of the pedagogical and educational concepts. According to the authors it is important to distinguish them. Education is a socially significant process on purposeful management of the formation and development of personality focused on some historically and culturally conditioned ideal images of a person. Pedagogy is the field of knowledge related to the comprehension of the integral human nature the basic ideals, principles and norms for the organization of the educational process. If education is identified with pedagogy, then this process acquires the status of scientific authority and becomes less accessible for criticism. In its turn pedagogy turns out to be biased by the interests for the organizer of the educational process (a certain social institution). This can be found today in the case of neuro-pedagogy and neuro-education.

Neuro-pedagogy elevated to the rank of social technology through the simplification and commercialization of ideas and methods loses its humanistic potential that it initially embodied: a deeper understanding of the processes for functioning and development of psyche, the individualization of pedagogical interaction. Researchers point out the possibility of dehumanization in the process of proliferation of scientific ideas of brain [17–19]. Neuro-pedagogy is often understood as the introduction of neurotechnologies into the educational process. Neurotechnology is a set of processes, materials, methods and relevant conceptual ideas related to the achievements of neuroscience knowledge and the possibilities of its use in various fields of activity. Neurotechnologies penetrate into education at various levels: 1) as technical devices; 2) as didactic means and adaptation techniques; 3) as methodological principles and theoretical knowledge; 4) as conceptual / paradigmatic ideas. And despite the methodological and ethical problematic nature of the neuro-technological reduction of the pedagogical process, the socio-economic project “neuro-education” is being formed.

What does it mean this term? Five semantic conceptual blocks of neuro-education were identified: 1) the training of specialists in the field of neurotechnologies; 2) popularization of knowledge obtained in innovative research in neurobiology; 3) the introduction of neurotechnologies as didactic, adaptation techniques, technical means and neuro-devices in the educational process; 4) a business project using the novelty effect to form a new market sector; 5) the implementation of the transhumanist project of the future.

V. NEUROTECHNOLOGY IN MODERN EDUCATION

The authors analyze the content of these areas in order to identify potential risks of the “neuro-education” project.

Training of specialists in the field of neurotechnology. Giving an overview of the new professions with the prefix "neuro". A. Payevsky and A. Khoruzhaya distinguish the following general directions: neuro-medical engineering, neuro-pharmacology, neuro-leisure, artificial intelligence (neuro-assistance) [20]. These areas are already quite widely represented in the neurotechnology market and require specific
training of specialists for their further development and implementation. In this case, neuro-education satisfies the public demand for professions related to the latest technologies. However, one should not forget about the “ethical vigilance” [17], which must necessarily accompany new serious opportunities to change social and humanitarian reality. For example, what moral principles and norms should guide a neuro-interface designer, a mind trainer, a designer of tools for teaching states of consciousness, an expert on the child’s “future image”, an emotion designer, a producer of the semantic field [21]? These professions, presented in the Atlas of New Professions, developed by the Agency for Strategic Initiatives (Skolkovo) in 2015, already have recommendations for universities, employers and labor markets. Some of them make think about the image of the future that the authors of the document broadcast: is there a place in this future for such values as individual autonomy, freedom, self-determination, etc.? The authors believe that the application itself for the training of such specialists should be subject to ethical and humanitarian expertise. Great opportunities and high risks in the development and application of neurotechnologies make high demands on humanitarian and ethical training of specialists in the field.

**Popularization of knowledge gained in innovative research in neurobiology.** The knowledge gained as a result of neuroscience research is of wide public interest, since it concerns the most mysterious in human nature - consciousness. However, the popularization of knowledge is a very responsible process. Information about scientific and technical achievements determines enough seriously the picture of the world for modern man. It really performs an educational function, forming an idea about itself and the surrounding reality, about the norms and value-target orientations of activity. Therefore you should be attentive to the goals for popularization of knowledge and characteristics of the provided content.

Today the most popular tool for popularization is the Internet. Therefore as an example of activities to promote neuroscience, materials from the sites of some organizations and associations that consider education in the area as their mission were considered. The information is presented most objectively and widely on the website of the Dana Foundation charity [22] which seeks to promote brain research and inform the public about the potential of this research. The Foundation promotes dialogue between researchers and non-professionals by providing reliable information on the latest advances in brain research through free publications and websites; engages people all over the world through Alliances and International Brain Awareness Week; covers important brain information via social networks.

In RuNet a similar mission is being carried out too. For example, according to the “Science in RuNet” catalog, the most significant sites in this area are: neuronovosti.ru; neuroscience.ru; Neurotechnology.rf. It should be noted that Russian-language portals are extremely rare publications and analytical materials that highlight the results of neuroscience research and technology in terms of socio-ethical and legal issues. Content is shaped as propaganda of the technocratic picture of the world. Quite often there are transhumanist publications where the imperfection idea of human nature is actively pursued and the need for its technological transformation is justified. Such kind of idea turns out to be economically significant: it opens up great prospects for the formation new needs and the expansion the neurotechnology market. It is not by chance that the tasks of the Neuro-Education project subgroup of the WG NTI Neuro-Net have much in common with the tasks of the transhumanist movement [23]. This trend can be denoted as dehumanization, commodification of the educational environment.

The introduction of technical tools and devices developed on the basis of neuroscience research into the educational environment. One of the directions of such implementation is the development of educational games based on the study of cognitive functions. For example, in France, the Ludo project is being developed - “software for an exciting study of the basics of numbers and reading in kindergarten and elementary school. The software will be presented in the form of a set of tablet games and combines all the ideas that have positively proven themselves in the study of the mechanisms of reading and counting” [11]. The development of such educational games was carried out earlier without requiring high technologies and financial investments. But the advancement of high technologies and the commodification of education change the situation: educational games involve complex technical tools and an expensive implementation process. It is difficult to say how much the expectations will be justified, and whether educational games of the new generation will really be effective. However, the ideological component of some projects is already alarming now.

The BiTronicsLab company at the I All-Russian Conference on Neuro-Formation and Cognitive Sciences in Moscow (2018) demonstrated the work of the “Neuro-molelist” new generation designer set. The set includes bio-signal sensors and software on a computer which, together with Lego Education robotics allow creating controlled robotic systems [24]. This kind of learning games form an idea of a person as part of biotechnological systems, create ideological prerequisites for perceiving cyborgization as the norm.

Gamification of education and improvement of the quality of online education services, their adaptation to the individual characteristics of each student are associated with the development of neuro-interface technology. The emergence of non-invasive interfaces allows building far-reaching plans for the inclusion in the educational space of virtual and augmented reality, technologies for monitoring and stimulating brain functions. For example, in the BASIS NEURO project, it was stated: “To improve the quality of education, monitoring and neuro-stimulation technologies can be introduced into the educational process. Monitoring in the learning process is necessary for the individual determination of the time phases most suitable for storing information. Educational services will be able to rely on the speed of thought of a particular person and on the individual features of the assimilation of information by him… Neuro-stimulation to improve the quality of cognitive processes” [25]. Head of the Department of Computer Educational Technologies at ITMO University, Scientific Director of the International Laboratory “E-learning Technologies” Lyubov Lisitsyna also said: “courses lies in the
development of e-learning technologies, in the use of new models and methods for the implementation of neural interfaces, for the expansion of brain resources” [26].

The idea of improving cognitive processes in subclinical and nonclinical practice as noted by researchers in the field of neuro-ethics is one of the most dangerous in the development of neurotechnologies [17, p.14] because it is about interfering with human nature. This inevitably gives a number of ethical, humanitarian and social problems, for example, confidentiality, personal autonomy, identity, discrimination, etc. [4, 17, 27, 28]. Meanwhile the use of pharmacological and technical means of direct influence on the brain beyond medical purposes is becoming a real practice and subject of design in social policy (for example, in neuro-education) and in business (for example, the market of nutritional supplements for memory improvement). Here the authors mention the well-known precedents for the systematic use of neuro-stimulators in educational practice. It is not a secret to the spread of the use of pharmaceuticals that improve memory, attention, increase efficiency, among students and older schoolchildren [3, 19, 29, 30].

**Neuroscience as a business project and one of the key segments of global market**

Neurotechnology today is considered one of the most promising areas in the creation of "globally competitive technologies” [1]. In Russia, as part of a scientific technology initiative (WG NTI), projects related to neurotechnology are being united under the auspices of the industry union “Neuro-Net”, created in 2015. According to the Neuro-Net road map by 2035 at least 10 Russian companies will appear in the global B2C and B2B market segments with a total capitalization about 70 billion rubles each. Among the key market segments is “neuro-education”. Therefore, it is not by chance that all the meanings of this concept turned out to be related to economic benchmarks and market values. In Russia one of the subgroups of the industry union “Neuro-Net” and the Association of Neuroscience, coordinate the interaction between technology entrepreneurs and commercial companies, venture funds and development institutions around the task of forming a new market segment “Neuro education”. The extent to which it is possible to talk about humanist and a number of social values, is a big question.

In a special way I would like to emphasize the ideological connection between some tasks of the market subgroup “Neuro-Education” and the Russian transhumanist movement “Russia 45”: “the development of neural interfaces and technologies of virtual and reality in education; ... the creation of devices for memory enhancement and analysis of the use of brain resources; ... the creation of teaching and laboratory places for schoolchildren and students on the basis of neurotechnologies of expanded perception, optimized memorization and strengthening of cognitive functions and by 2035 - the full use integrated systems of natural and artificial intelligence” [23].

It becomes clear why neuroscience can be interpreted in some publications as a socio-political project to change human nature in the spirit of transhumanism [5]. Modern technologies, including neurotechnologies, creating new opportunities, claim to reconsider the human boundaries which create new risks and threats of a civilizational nature. This is a serious problem that has been engaged in bioethics, techno-ethics and neuro-ethics for more than a decade. Since the education system in society performs tasks related to the reproduction of the human in a person, all ideas and projects related to the introduction of neurotechnologies into this system need a wide public discussion and ethical expertise.

**VI. CONCLUSION**

The proliferation of neuroscience in pedagogy and the educational system is implemented on two levels: in the humanistic and technocratic paradigm. The humanistic paradigm is connected with the idea of a person as a complex bio-sociological self-developing system. The corresponding capabilities of neuro-pedagogy consist in a deeper and more complex understanding of the processes of functioning and development of the psyche in ontogenesis, as well as in the development of means for individualization of pedagogical interaction. The technocratic paradigm permits the reduction of pedagogy to the technology of managing the formation and development of cognitive systems. The complexity of human nature is leveled. The significance for the “technical” parameters of human improvement is hypertrophied. New possibilities of manipulating a person and his interests are opening up. Neuro-pedagogy, elevated to the rank of social technology through the simplification and commercialization of ideas and methods, loses its humanistic potential and is often interpreted as the introduction of neurotechnologies into the educational process.

Neuroscience is a modern socio-economic project, involving 5 possible directions for implementation: 1) training of specialists in the neurotechnologies; 2) popularization of knowledge obtained in innovative research in neurobiology; 3) the introduction of neurotechnologies as didactic, adaptation techniques, technical means and neuro devices technology in the educational process; 4) a business project that uses the novelty effect to form a new market sector; 5) Transhumanist project of the future.

There are serious concerns about the lack of broad public and professional ethical expertise of projects in neuro-education. Commercial, corporate and government interests in the implementation of these projects are not identical to the ideas of good in matters of human development and society.

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**References**


