

# Neuropedagogy in Contemporary Formal and Non-Formal Education

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**Abstract:** *The article reveals the concept of neuropedagogy, in relation to current forms of educational practices. In the conditions of significant advances in the field of neuroscience, the relevance and expediency of research is determined by the opportunities that open up before the use of research on brain activity and neural processes in educational activities. On the one hand, discoveries in the neuroscience can increase the effectiveness of educational activities, their formal and non-formal areas. On the other hand, there are a number of paradigmatic and practical limitations associated with the use of the neuroconcept in various forms of educational activities. Opportunities include: increasing attention, overcoming personal limitations, detection of specific neuro-consistent methodic and didactic techniques. The limitations include some paradigmatic conditionality of the neuroconcept, which to some extent limits the heuristic qualities of thinking due to the dominance of mental practices and various formalizations. Thus, the balanced and appropriate application of neuropedagogical approaches in both formal and non-formal education is of great importance. Neuropedagogical methods are becoming extremely important in the context of digitization of the space of interaction between people and the emergence of the so-called Z-generation. Critical evaluation and timely application of neuropedagogical practices, in our opinion, can significantly expand the potential for both formal and non-formal education.*

**Keywords:** *Neuroscience; neurophysiology; neuropsychology; heuristic thinking; neuropedagogical models; cognitive psychology; dominant management.*

**How to cite:** Gvozdii, S., Bakhov, I., Pienov, V., Palamarchuk, S., Dudnyk, N., & Petrukhan-Shcherbakova, L. (2022). Neuropedagogy in Contemporary Formal and Non-Formal Education. *BRAIN. Broad Research in Artificial Intelligence and Neuroscience*, 13(4), 264-279. <https://doi.org/10.18662/brain/13.4/387>

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## Introduction

Recent neurophysiological and neuropsychological research, combined with artificial intelligence systems, lead to some advances in pedagogical anthropology. Often pedagogical ideas about the human take the functions of the brain and nervous system as starting points (Sarancha et al., 2021). At the same time, models of classical pedagogical anthropology are gradually receding into the background. This phenomenon, along with great didactic and methodological opportunities, creates a number of limitations in the implementation of educational practices. From the point of view of the classical pedagogical anthropology, according to, for example, Ushinskiy (2002a; 2002b), an individual is a whole, much greater than just the brain and nervous activity.

The contemporary phenomenon of the so-called digital Z - generation with all its pedagogical opportunities, also shows significant problems of pedagogical and anthropological narrowness of the existing ideas, exacerbating the already multiplying problems, Sapa (2015). In our opinion, a detailed review of the neuro-approach in formal and non-formal education systems will shed light on both the opportunities and problems associated with the application of neuropedagogical practices and, therefore, will contribute to their more conscious and timely application.

Thus, the current rapid development of research on the processes taking place at the level of the human nervous system has created significant opportunities for their application in pedagogical theory and practice (Prots et al., 2021). Both special studies of the effectiveness of certain methods and methodologies, and the development of specific neurological didactic techniques are becoming possible. It is possible to state a boom of neuroapproaches in various spheres of both formal and non-formal education. This is especially true for non-formal education.

**The hypothesis of the study** is that the theory and practice of neuropedagogy has both opportunities and limits for formal and non-formal forms of educational activities. Theoretical possibilities include a significant expansion of ideas about the brain and nervous system activity, allowing to create new pedagogical concepts that have a fairly high cognitive potential. The theoretical limitations include some narrowing of the concept of pedagogical anthropology within the discourse of the neuroscience. This narrowing at the level of pedagogical anthropology, combined with the general context of postmodernism, prevailing in various fields of knowledge, as well as the phenomenon of Z-generation - limits the potential of holistic

pedagogical-theoretical understanding of the current situation. Practical opportunities include neuro-consistent methods and pedagogical moves based on the principles of functioning of both the brain and the nervous system as a whole. However, in case of excessive increase of neuropedagogical practices, other methods of pedagogical influence may be damaged, which contradicts the systemic multidimensional comprehensive approach to educational activities. On this basis, this study develops ideas for the synthesis of formal and non-formal approaches to educational activities in the context of neuropedagogical theory and practice.

The **purpose** of the study is to analyze the possibilities and limitations of using the theory and practice of neuropedagogy in formal and non-formal education.

Logical and systematic analysis, as well as modeling in pedagogical processes are used as a **research method**.

The theoretical and practical significance of the obtained **results** determines the place and criteria for the effective applicability of neuropedagogical theory and practice in formal and non-formal education.

**Research objectives.** Achieving the purpose of the analysis of the capabilities and limitations of the theory and practice of neuropedagogy in formal and non-formal education has led to solution of the following problems.

1. On the basis of the literature review to substantiate the working definition of neuropedagogy. And also, to distinguish between formal and non-formal education.

2. To substantially reveal the principles of the theory and practice of neuropedagogy.

3. Show the features and capabilities of neuropedagogy in formal and non-formal education.

4. To analyze the limitations that arise in the process of using neuropedagogy in educational practices.

In general, neuropedagogical research is based on the methods and materials of recent discoveries in the field of neuropsychology and neurophysiology. Theoretical constructs of ideas about the human from the given areas, neuromodels and materials of experimental observations are used. Including practical observations of neurosurgeons, as well as the widespread research using electronic equipment: encephalographs, tomographs and other devices that record various activities of the brain and nervous system.

Research in the field of neurophysiology and neuropsychology reveals a fairly high cognitive potential of methods based on learning the brain functions. In the works of Robleto & Thompson (2008); Rattenborg, Amlaner & Lima (2000); Phan et al. (2002); Pezawas et al., (2005); McEwen (2001); McCrory et al. (2000) the course of neuroprocesses is shown at the level of physiology. Such research provides a basis for the selection of neuro-consistent physiological techniques used in pedagogical practice.

Special attention should be paid to the use of neuro-practices in the process of self-management, which can be effectively used in the learning process. This is indicated by the study of Maquet et al. (2000), based on the principles of neuroactivity of the brain. The use of neuro-practices is also successful in overcoming stress, which, among other things, often accompanies educational activities. Such studies are presented, for example by McEwen (2000).

Based on the data of neuroscience, neuropedagogy builds its theory and practice, forming certain ideas about human as a subject of the educational process and offering didactic methods of neuro-consistent impact.

In current reality, the practices of neuropedagogical educational impact are represented mostly in non-formal education. They are often semi-intuitive and spontaneous. This, to some extent, complicates recordings of research observations and, accordingly, their analysis.

### Literature Review

The distinctive division of the approaches to educational activities into formal and non-formal is presented in a fairly uniform way in the literature. For example, Babaeva (2014) conducts, in our opinion, a fairly detailed analysis of the differences between formal and non-formal education. The results of the analysis are presented in table 1.

**Tab. 1.** Comparative analysis of formal and non-formal education.  
The table is borrowed from the author, Babaeva (2014)

| Education  | Formal  | Non-formal              |
|------------|---|-------------------------|
| Objectives | Long-term and more general                    | Short-term and specific |
|            | Officially acknowledged education certificate | No certificate          |
| Duration   | Long cycle, full day, general                 | Short cycle, part-time, |

|                                    |  |  |
|------------------------------------|--|--|
|                                    | schedule   | individual schedule or as convenient   |
| Scope                              | Standardized, focused on the main provisions of the study material | Individualized, result-oriented  |
|                                    | Academic   | Practical  |
|                                    | Rigidly structured   | Flexible, personality-oriented   |
|                                    | Enrollment requirements determine the level of students            | Students determine the entry requirements  |
| Location                           | In educational institutions, regardless of the place of residence  | Focused on proximity to the place of residence   |
| Resource consumption               | Resource-consuming   | Resource efficient   |
| Control                            | External / hierarchical  | Internal / democratic / self-government  |
| Pedagogical support after training | No or formal   | Based on self-government, caused by interest in the results and experience of other participants |

Here, based on a fairly deep and comprehensive analysis, the results of the analysis are presented, which can be used in the context of the present study. The great flexibility, mobility and adaptability of non-formal education is obvious, which determines a wide range of opportunities for the free application of neuropedagogical practices.

Of great interest is the synthesis of formal and non-formal approaches to education, which allows to preserve the positive features of formal education and at the same time to complement them with non-formal approaches. This is also pointed out by Minzer & Babaeva (2012). Klyucharev (2003) also devotes research to the search for a measure of the synthesis of formal and non-formal approaches. Shnayder's work, in our opinion, presents the most practice-oriented results of the search for such a synthesis in external forms of higher education, Shnayder (2004). In the same context, the work of a teacher-practitioner, the founder of the author's

school Zitser (2007) is interesting. Foreign authors have also been analyzing the problems of combining formal and non-formal approaches to educational activities for a long time. Mayo (1999), Rogers (1969) and Simkins (1977) also search for a synthetic direction of educational activity. Although the bias is on the dominance of non-formal approaches.

There are more and more articles on the theory and practice of neuropedagogy each year. Klemantovich, Stepanov (2015) refer theoretical and practical elements of education based on recent neurophysiological and neuropsychological research to the content of neuropedagogy (Klemantovich & Stepanov, 2015). Pervushina & Osetrin (2017) point to the synthetic nature of neuropedagogy, showing that it combines neuropsychology, cognitive neurology, differential psychophysiology, neurophysiology, cybernetics and pedagogy. Moskvina & Moskvina (2001) analyze in detail the applied aspects of neuropedagogy, showing ways to apply neurodiscoveries in pedagogical practices.

In a sense, the theoretical foundations of neuropedagogy were laid by Vygotsky (1927), who singled out the so-called “lower mental functions” and “higher mental functions”. The “lower” include visually effective thinking, emotional memory, involuntary attention and others. The “higher” include verbal-logical thinking, speech, arbitrary attention, as well as a number of other functions. In addition, Vygotsky developed the idea of “the zone of immediate development”, proceeding from the phases of maturation of the brain. In the same context, the doctrine of the dominance by Uhtomskiy (2020) deserves a special mention. The direct creator of neuropsychology is Luria (2003), who carried out further research on the systemic structure of higher mental functions and the conceptual basis of their localization.

In the Russian language space, neuropedagogy was first studied by Moskvina & Moskvina (2001), Moskvina et al., (2013) and other authors who develop the ideas of Luria (2003), including the laws of education in its relationship with the processes of brain function and the development of the human psyche.

The analysis of the theory and practice of neuropedagogical knowledge is also carried out in foreign literature. Thus, Chojak (2018) analyzes in detail the theoretical foundations and the problem field of neuropedagogy.

## **Application of neuropedagogy in the practices of formal and non-formal education**

From the point of view of neuropedagogy, learning is the process of changing the neural connections of the brain in the process of educational activities. Research in the field of changing neural connections in the brain under the influence of various factors and educational practices allows to find the most effective educational strategies in the educational process. Studies show that neural processes in the brain are nonlinear and can be partially described by neuromodels that contain a chaotic factor.

Knowledge of the nonlinear processes occurring in the brain and their use in both formal and non-formal educational practices allows to identify the key factors in the educational environment and, accordingly, to pay special attention to them.

The regularities of the formation of new neural connections, changes (destruction) of the old ones are associated with such parameters of brain function as neuroridity and neuroplasticity, which allow on the one hand to assess learning, and on the other hand to study the durability of learning material digestion. The ratio of the parameters of neuroridity and neuroplasticity will show the extent and degree of response of the brain to certain forms of educational impact.

One of the most important areas of both theory and practice of neuropedagogy is the study of the dominant hemisphere in students. This phenomenon is called hemispheric asymmetry. And, according to the type of the dominant hemisphere a learning strategy that meets the characteristics of a particular type of perception is developed.

Tunkun (2008) provides a classification of the learning strategies for the right-hemisphere and left-hemisphere people.

The training strategies for the left-hemisphere people are dominated by such features as the study of material without a specific practical purpose. This means inclusion of the direct cognitive interest, allowing a deep and diverse coverage of educational material. According to Tunkun (2008), the left-hemisphere people have the ability to organize learning independently. In such conditions, the training of the “left hemisphere” people is the most effective and efficient. Also, for such people the structure and logical construction of the educational material which is of great importance that provides its highest-quality digestion. One can note the high level of logic present in the expression of thoughts by “the right-hemisphere people”. In the process of making choices and making decisions, such people are guided



more by rational logic. The best working condition for them is a complete silence.

In the strategies of training “right-hemisphere” people there is an importance of goal-setting - it is important for them to know the purpose of the training material and understanding of the learning outcome. Such people are characterized by effective teamwork. Of great importance for the “right hemisphere” people is the multidimensional presentation of the material, enriched with additional illustrations, examples and parallels from other fields of knowledge. When it comes to making a choice or a decision, the “right hemisphere” people mainly rely on intuition. It is not a problem for them to work in conditions of high noise background. The planning process is almost uncommon for such people. They are based on a holistic perception of certain processes.

In the West and the United States, research on how knowledge of the human brain can be applied in education has been conducted since the late 1970s and early 1980s. These studies were not limited to the use of hemispheric asymmetry and focused on the inclusion of various features of brain behavior in learning.

During the period of studying neuropedagogical theory and practice, approaches have been formed that allow to determine quite accurately the most preferred cognitive strategies for students. And further using the advantages of the dominant hemisphere to gradually teach to solve complex problems.

Since most often learning takes place in mixed groups, it creates the conditions when students help each other, performing various learning tasks, mutually enriched with strategies of the non-dominant hemisphere. Thus, interhemispheric connections are gradually formed and there is some alignment of the hemispheric balance.

The most important direction of neuro-consistent education is the development of skills of concentration and deconcentration of attention in students, their alternation and application according to the situation and features of brain function. In this case, the alternation of concentration and deconcentration of attention can significantly increase the effectiveness of awareness and digestion of educational material.

## **Limitations on the use of neuropedagogy in educational research and practice in the context of bioethics**

Fascination with the practices of neuropedagogy, as already noted, creates great opportunities for the realization of brain resources in the process of educational activities. At the same time, it is possible to observe some narrowing of pedagogical and anthropological representations about the brain and the processes proceeding in it. Therefore, in our opinion, it is important to consider the bioethical aspect of the application of neuropedagogical educational practices. The concept of bioethics is focused on the protection of human individuality, Mescheryakova (2011). This means that students need to know what the impact will be, what the end result will be, whether there are “counterindications” to certain teaching methods. And also informing students not only about the so-called ideal end product of education, but also about the adopted pedagogical and anthropological ideas.

The current situation in education, which can be described as cyborgization of human, Spasskiy (2021), gives rise to the need to find ways to preserve human in the understanding of classical pedagogical anthropology. This situation is associated with the multidimensional penetration of virtual reality into human life. Dominance of gadgets and the so-called “digital poisoning” has spawned a whole digital z-generation. Pedagogical activity in the space of which it is important to carry out from the standpoint of bioethics. Otherwise, a person can gradually turn into a real cyborg. In this regard, Spasskiy (2021) emphasizes: “The totalitarian movement of technos on the planet, in fact, has given rise to two co-directional trends. This is the gradual transformation of a human into a machine. From the implantation of artificial body parts, to the machine algorithmization of consciousness. And even bringing consciousness to the periphery of technos through a system of diverse electronic gadgets. And the second trend is the transformation of a robot into a human. From the idea of admiring technology and even worshiping the machine to the idea of its almost deification in the image of a supercomputer controlling everything. This is not about a utopian future. This is today’s reality”, Spasskiy (2021, p. 133).

## **Neurographics as an example of neuropedagogical practice of synthesis of formal and non-formal approaches**

Neurographics can be considered as one of the rather effective tools of neuropedagogical practice in both formal and non-formal education. As already noted, from the standpoint of neurophysiology, the ability to successful adaptation and development is due to formation of new neural connections, which are the content of human thinking, response, behavior, and, consequently, life in general. Among the scientific works devoted to the study of neurographics, we should highlight the dissertation research of Saveleva (2018) “Psychological foundations of neurographics”, as well as articles by Ananyeva (2018), Kravtsova (2018), Usatyh (2020). The so-called background picture of the world, or background knowledge, determines the presuppositions that filter attention and thinking.

Pedagogical work with such tools is conducted by so-called indirect methods. This is due to the nonlinearity of the brain’s response to certain pedagogical influences, as well as the existence of “filters” - special neural connections that block in-depth learning, Mohova (2019).

In this context, the growing dissatisfaction with life of many contemporary people is associated not so much with rapid changes in environmental factors, but with the lack of skills of pure perception, sometimes called “beginner consciousness”, enabling to find quick non-standard spontaneous solutions.

Neurographics is designed to solve this set of problems, Piskarev (2020). The stems “neuro” and “graphics” express the relationship between the nervous system, the human brain and its graphic practice, Mohova (2019). When creating a neuroimage, there are changes in the nervous system of the painter through the emergence of new neural connections through visual-motor perception and transformation of images and symbols. This approach allows to work with the deep layers of the psyche. In this case spontaneous, intuitive drawing is always the output of the background state or filters of perception on the surface of the consciousness. Mohova (2019) identifies 6 stages of neuroimaging: actualization, ejection, rounding, merging, field lines and verbalization.

Thus, neurographics is a creative method of personal transformation and work with the background layers of human life and can be successfully used in both formal and non-formal practices of educational activities.

## Conclusion

The distinction between formal and non-formal approaches to educational activities is associated with the continuous strengthening of the importance and share of the non-formal component. This is due to the continuous process of democratization and digitalization of educational practices. In these conditions, the role of formal features is reduced and at the same time the marketing (product-oriented) and practical components are strengthened. On the one hand, this process reduces the influence of bureaucratic formalism of educational projects at various levels. On the other hand, it reduces the possibility of mastering the ideological, methodological and theoretical components of educational programs. Due to their low demand in non-formal educational programs. Under these conditions, each student becomes an expert in choosing what and how to learn. This often isolates the student from the traditional classical approach to education, thereby reducing the quality of education.

In our opinion, the application of neuropedagogical approaches to both formal and non-formal educational practices can be effective provided that they are applied in a timely manner in appropriate cases. At the same time, such approaches should not be absolutized, being relied on completely. A clear discrepancy between pedagogical and anthropological models of the classics of pedagogical thought and contemporary neuropedagogical models of human requires further research. Further development requires the holistic pedagogical and anthropological model, which synthetically includes both classical pedagogical concepts and the results of recent neuropedagogical research and practices.

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## References

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- Ananyeva, V. P. (2018). Neyrografika kak art-terapevticheskiy metod soprovozhdeniya onkopatsientok v stressovoy situatsii himioterapii [Neurographics as an art-therapeutic method for accompanying cancer patients in a stressful situation of chemotherapy]. *Psibologiya i psibotekhnika* [Psychology and psychotechnics], 3, 101–111.  
<https://cyberleninka.ru/article/n/neyrografika-kak-art-terapevticheskiy-metod-soprovozhdeniya-onkopatsientok-v-stressovoy-situatsii-himioterapii>
- Babaeva, E. S. (2014). Comparative analysis of formal and non-formal education [Sravnitelnyy analiz formalnogo i neformalnogo obrazovaniya]. *Vestnik universiteta* [University Bulletin], 6, 234–237.  
<https://cyberleninka.ru/article/n/sravnitelnyy-analiz-formalnogo-i-neformalnogo-obrazovaniya>

- Chojak, M. (2018). Neuropedagogy as a Scientific Discipline: Interdisciplinary Description of the Theoretical Basis for the Development of a Research Field. *World Academy of Science, Engineering and Technology International Journal of Educational and Pedagogical Sciences*, 12(8), 1085-1088.  
[https://www.researchgate.net/publication/331231903\\_Neuropedagogy\\_as\\_a\\_scientific\\_discipline\\_interdisciplinary\\_description\\_of\\_the\\_theoretical\\_basis\\_for\\_the\\_development\\_of\\_a\\_research\\_field](https://www.researchgate.net/publication/331231903_Neuropedagogy_as_a_scientific_discipline_interdisciplinary_description_of_the_theoretical_basis_for_the_development_of_a_research_field)
- Klemantovich, I. P., & Stepanov, V. G. (2015). Neyropedagogika: predmet issledovaniya [Neuropedagogy: the subject of research]. *Fundamentalnyie issledovaniya*, 2(11), 2464-2468. <https://fundamental-research.ru/ru/article/view?id=37469>
- Klyucharev, G. A. (2003). Samoobrazovanie i radikalnyie pedagogiki: vozmozhen li kompromiss? [Self-education and radical pedagogy: is a compromise possible?] *Innovation in Education: Collection of Conference Proceedings*, 29, 322-324. St. Petersburg Philosophical Society.  
<http://anthropology.ru/ru/text/klyucharev-ga/samoobrazovanie-i-radikalnaya-pedagogika-vozmozhen-li-kompromiss>
- Kravtsova, K. Yu. (2018). Ispolzovanie mandal i neyrografiki pri SEV u pedagogov [The use of mandalas and neurographics in the treatment of burnout syndrome in teachers.]. *Simvol nauki*, 8, 98–99.  
<https://cyberleninka.ru/article/n/ispolzovanie-mandal-i-neyrografiki-pri-sev-u-pedagogov>
- Luria A. R. (2003). *Osnovy neyropsihologii* [Fundamentals of Neuropsychology]. Publishing Center “Academy”.  
<https://www.litmir.me/br/?b=225405&p=1>
- Maquet, P., Laureys, S., Peigneux, P., Fuchs, S., Petiau, C., Phillips, C., et Aerts, J., Del Fiore, G., Degueldre, C., Meulemans, T., Luxen, A., Franck, G., Van Der Linden, M., Smith, C., & Cleeremans, A. (2000). Experiencedependent changes in cerebral activation during human REM sleep. *Nature Neuroscience*, 3, 831–836. <https://doi.org/10.1038/77744>
- Mayo, P. (1999). Gramsci, Freire and Adult Education: Possibilities for Transformative Action. *International Review of Education* 47(3), 395–403.  
<https://doi.org/10.1023/A:1017970330226>
- McCorry, E., Frith, U., Brunswick, N., & Price, C. (2000). Abnormal functional activation during a simple word repetition task: A PET study of adult dyslexics. *Journal of Cognitive Neuroscience*, 12, 753–762  
<https://doi.org/10.1162/089892900562570>
- McEwen, B. S. (2000). The neurobiology of stress: From serendipity to clinical relevance. *Brain Research*, 886, 172–189. [https://doi.org/10.1016/s0006-8993\(00\)02950-4](https://doi.org/10.1016/s0006-8993(00)02950-4)

- McEwen, B. S. (2001). Invited review: Estrogen effects on the brain: Multiple sites and molecular mechanisms. *Journal of Applied Physiology*, 91, 2785–2801  
<https://doi.org/10.1152/jappl.2001.91.6.2785>
- Mescheryakova, T. V. (2011). Bioetika na peresechenii nauchnogo i vnenauchnogo znaniya [Bioethics at the intersection of scientific and non-scientific knowledge]. *TSPU Bulletin*, 10(112), 216–221.  
[https://vestnik.tspu.edu.ru/files/vestnik/PDF/articles/mesheryakova\\_t.v.216\\_221\\_10\\_112\\_2011.pdf](https://vestnik.tspu.edu.ru/files/vestnik/PDF/articles/mesheryakova_t.v.216_221_10_112_2011.pdf)
- Minzer, I. V., Babaeva, E. S. (2012). Proektirovanie programmy professionalnogo obucheniya na osnove integratsii formalnogo i neformalnogo obrazovaniya [Designing a vocational training program based on the integration of formal and non-formal education]. *Mir obrazovaniya – obrazovanie v-mire*, 10, 46-59. <https://cyberleninka.ru/article/n/proektirovanie-programmy-professionalnogo-obucheniya-na-osnove-integratsii-formalnogo-i-neformalnogo-obrazovaniya>
- Mohova, Yu. A. (2019). Plastichnost golovnogo mozga i neyrografika [Brain plasticity and neurographics]. *Russian Journal of Education and Psychology*, 10(4), 61-66. <https://cyberleninka.ru/article/n/plastichnost-golovnogo-mozga-i-neyrografika>
- Moskvin, V. A., & Moskvin, N. V. (2001). Neyropedagogika kak prikladnoe napravlenie pedagogiki i differentsialnoy psikhologii [Neuropedagogy as an applied direction of pedagogy and differential psychology]. *Bulletin of the Orenburg State University*, 4, 34–39. [http://vestnik.osu.ru/2001\\_4/5.pdf](http://vestnik.osu.ru/2001_4/5.pdf)
- Moskvina N. V., Moskvina, K. V., & Rakitina, M. A. (2013). Korrektsiya detey s umstvennoy otstalostyu metodami neyropedagogiki [Correction of children with mental retardation by methods of neuropedagogy]. In R. L. Ivanova, O. V. Kozyreva (Eds), *Lechebnaya fizicheskaya kultura: dostizheniya i perspektivny razvitiya* [Remedial physical culture: achievements and development prospects] (pp.186–188). Publishing house of the Russian State University of Physical Culture, Sports, Youth and Tourism.
- Pervushina, N. A., & Osetrin, K. E. (2017). Neyropedagogika kak vyrazhenie simvolizma bioetiki [Neuropedagogy as an Expression of Bioethics Symbolism]. *Pedagogical Review*, 2(16), 198–208.  
[https://npo.tspu.edu.ru/archive.html?year=2017&issue=2&article\\_id=6395](https://npo.tspu.edu.ru/archive.html?year=2017&issue=2&article_id=6395)
- Pezawas, L., Meyer-Lindenberg, A., Drabant, E. M., Verchinski, B. A., Munoz, K. E., Kolachana, B. S., Egan, M. F., Mattay, V. S., Hariri, A. R., & Weinberger, D. R. (2005). 5-HTTLPR polymorphism impacts human cingulate-amygdala interactions: A genetic susceptibility mechanism for depression. *Nature Neuroscience*, 8, 828–834.  
<https://doi.org/10.1038/nn1463>

- Phan, K. L., Wager, T., Taylor, S. F., & Liberzon, I. (2002). Functional neuroanatomy of emotion: A meta-analysis of emotion activation studies in PET and fMRI. *Neuroimage*, 16(2), 331–348. <https://doi.org/10.1006/nimg.2002.1087>
- Piskarev, P. M. (2020). *Neyrografika. Algoritm snyatiya ogranicheniy* [Neurography. Algorithm for removing restrictions]. Eksmo.
- Prots, R., Yakovliv, V., Medynskiy, S., Kharchenko, R., Hryb, T., Klymenchenko, T., Ihnatenko, S., Buzhyna, I., & Maksymchuk, B. (2021). Psychophysical training of young people for homeland defense using means of physical culture and sports. *BRAIN. Broad Research in Artificial Intelligence and Neuroscience*, 12(3), 149-171. <https://doi.org/10.18662/brain/12.3/225>
- Rattenborg, N. C., Amlaner, C. J., & Lima, S. L. (2000). Behavioral, neurophysiological and evolutionary perspectives on unihemispheric sleep. *Neuroscience and Biobehavioral Reviews*, 24, 817–842. <https://pubmed.ncbi.nlm.nih.gov/11118608/>
- Robleto, K., & Thompson, R. F. (2008). Extinction of a classically conditioned response: Red nucleus and interpositus. *Journal of Neuroscience*, 28, 2651–2658. <https://psycnet.apa.org/record/2008-07212-030>
- Rogers, C. (1969). *Freedom to Learn*. Charles E. Merrill.
- Sapa, A. V. (2015). Pokolenie Z – pokolenie epohi Federalnyie gosudarstvennyie obrazovatelnyie standartyi [Generation Z - Generation of the era Federal State Educational Standards]. *Pedagogicheskaya masterskaya. V syo dlya uchiteleya!* [Pedagogical workshop. Everything for the teacher!] 7, 2-9. <https://cyberleninka.ru/article/n/pokolenie-z-pokolenie-epohi-fgos>
- Sarancha, I., Maksymchuk, B., Gordiichuk, G., Berbets, T., Berbets, V., Chepurna, L., Golub, V., Chernichenko, L., Behas, L., Roienko, S., Bezliudna, N., Rasskazova, O., & Maksymchuk, I. (2021). Neuroscientific Principles in Labor Adaptation of People with Musculoskeletal Disorders. *BRAIN. Broad Research in Artificial Intelligence and Neuroscience*, 12(4), 206-223. <https://doi.org/10.18662/brain/12.4/245>
- Saveleva, O. A. (2018). *Psibologicheskie osnovyi neyrografiki* [Psychological foundations of neurographics] [Unpublished Doctoral dissertation]. Yaroslavl State Pedagogical University named after K. D. Ushinsky.
- Shnyder, I. R. (2004). *Pedagogicheskie usloviya obespecheniya kachestva obucheniya studentov eksternata v vuzę* [Pedagogical conditions for ensuring the quality of teaching of external students at the university] Unpublished Doctoral dissertation]. Stavropolskiy Gosudarstvenniy University.
- Simkins, T. (1977). *Non-formal education and development. Some critical issues*. Department of Adult and Higher Education, University of Manchester.
- Spasskiy, I. D. (2021). Metafizicheskie aspekty kiborgizatsii cheloveka v kontekste tehnogeneza [Metaphysical aspects of human cyborgization in the context

- of technogenesis]. In Yu. M. Osipov, E. S. Zotova (Eds.), *Rossiya v peredele: tsivilizatsiya, tehnogenez, ekonomika* [Russia in redistribution: civilization, technogenesis, economics] (pp. 133-138). Faculty of Economics, Lomonosov Moscow State University.  
<https://www.econ.msu.ru/sys/raw.php?o=78333&p=attachment>
- Tunkun, Ya. A. (2008). Osnovy neyropedagogiki: istoriya, teoriya i praktika [Fundamentals of neuropedagogy: history, theory and practice]. *Bulletin of the Russian State Pedagogical University*, 73(2), 203-208.  
<https://cyberleninka.ru/article/n/osnovy-neyropedagogiki-istoriya-teoriya-i-praktika>
- Uhtomskiy, A. A. (2002). *Dominanta* [Dominant]. Piter.
- Usatyh, G. N. (2020). Korrektsiya trevogi i profilaktika panicheskikh atak metodom neyrografiki [Correction of anxiety and prevention of panic attacks using neurographics]. *Molodoy ucheniy*, 22(312), 485–490.  
<https://moluch.ru/archive/312/71035/>
- Ushinskiy, K. D. (2002a). *Pedagogicheskaya antropologiya. Chelovek kak predmet vospitaniya. Opyit pedagogicheskoy antropologii* [Educational anthropology. Man as a subject of education. Experience in pedagogical anthropology]. Vol. 1. Publishing House of the University of Russian Innovative Education.
- Ushinskiy, K. D. (2002b). *Pedagogicheskaya antropologiya. Chelovek kak predmet vospitaniya. Opyit pedagogicheskoy antropologii* [Educational anthropology. Man as a subject of education. Experience in pedagogical anthropology]. Vol. 2. Publishing House of the University of Russian Innovative Education.
- Vygotsky, L. S. (1927). Istoricheskiy smysl psihologicheskogo krizisa [The historical meaning of the psychological crisis]. *Collected works in 6 volumes. Volume 1. Questions of theory and history of psychology*. Pedagogy.  
[http://vygotsky.narod.ru/vygotsky\\_crisis.htm](http://vygotsky.narod.ru/vygotsky_crisis.htm)
- Zitser, D. (2007). *Prakticheskaya pedagogika: azbuka neformalnogo obrazovaniya* [Practical pedagogy: the alphabet of non-formal education]. Prosveschenie.