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FRAME «NEUROTECHNOLOGY», ROLE AND SIGNIFICANCE IN PODCASTS

This study investigates podcasts on the topic of «Neurotechnologies» to develop a frame model that organizes key directions and concepts within this field. Both quantitative and qualitative methods were used for the analysis, including discourse analysis, content analysis, and the KWIC method using the «AntConc» software.

As a result of the study, the frame was presented by four subframes: cognitive technologies, bioengineering and neurointerfaces, neurotechnologies in education, and phygital interfaces («phygital» integration of the physical and digital worlds), which are subdivided into slots and subslots.

The novelty of this research lies in the fact that it proposes, for the first time, a frame model of neurotechnologies within the lexicographical aspect. Previously, similar models were applied in other fields; however, their adaptation to lexicographic purposes has not been previously developed.

The analyzed podcasts demonstrate colloquial speech, incorporating English loanwoards, borrowings, abbreviations, and everyday life examples, making the content accessible to a broad audience. Ethical aspects related to their impact on society, health, and education are also explored.

This study will be valuable to both experts and the general public interested in modern technologies and their applications. The findings highlights the need for further research by including more podcasts to enable a deeper and more comprehensive analysis of the discussed topics.

Keywords: cognitive technologies, bioengineering, phygital, neurointerface, nanophotonics, cyborgization.

Introduction

In recent years, podcasts have become a significant tool for knowledge dissemination, including in the field of neurotechnologies – a rapidly developing area that has garnered interest from both the scientific community and the general public. Their role in popularizing the topic is particularly relevant, as the representation of neurotechnologies in the media space influences public perception.

The aim of this study is to develop a frame model of the concept of «Neurotechnology» through an analysis of podcasts.

The research object consists of podcasts in the field of neurotechnology, and the subject of the study is lexical units and terms within this domain.

The novelty of this work lies in the creation of a frame model of neurotechnologies that takes into account a lexicographic approach, which has not been previously applied in this field.

A frame, derived from the English term «frame» (meaning structure or framework), is understood in linguistics as a conceptual structure that represents an action scheme through the lens of human cognitive abilities. The concept of «frame» gained widespread recognition in cognitive linguistics following the works of M. Minsky.

It is essential to acknowledge the substantial contribution of American linguist Ch. Fillmore, who adapted the concept of «frame» in the late 1970s.

Frame analysis has been successfully applied in various domains, including transport logistics [1], digital economy [2], tourism [3], landscape design [4], migration law [5], media representation of cities [6], heat exchange equipment [7], education [8], and transplantation studies [9]. The identification of subframes facilitates the systematization of terminology and deepens the understanding of concepts.

One of the innovative directions in neurotechnologies is transient electronics, which employs biodegradable materials capable of dissolving within the human body without requiring surgical removal. The study by Adele F. and Diego G. demonstrates successful results on animal models, enabling further clinical trials [10].

Authors Vioalante I.R. and Okuere P. [11] argue that neurotechnologies have the most significant impact on individuals with cognitive disorders. However, ethical concerns remain at the core of scientific and public debates, with neuro-rights already being considered at the legislative level, as seen in Chile [12].

A frame model can be useful for analyzing terminological systems in neurotechnologies, particularly in major projects such as the Human Brain Project (EC, 2013), the China Brain Project (2016), and Elon Musk's Neuralink (2016).

The findings of this study open new perspectives for understanding how specific frames shape public perception.

Based on the above mentioned directions and technologies, this study focuses on the methods and approaches necessary for constructing the frame of neurotechnologies as represented in podcasts.

A podcast is a rapidly growing audio or video format consisting of a series of episodic programs that have firmly integrated into public discourse.

Materials and Methods

In constructing the frame model of the concept «Neurotechnology», we considered the fact that a frame includes a multi-level cognitive structure, including subframes, slots, and subslots.

The research corpus consists of 15 podcasts (4 video podcasts and 11 audio podcasts) in Russian and English languages in the field of neurotechnology from 2020 to 2024. The selected podcasts cover topics related to the development of neurotechnologies, including their practical applications, research potential, and ethical aspects, as presented on the «NeuroTrend», «Noosphera Project», and «NeuroTech» channels. These podcasts are intended for a broad audience, providing deeper understanding of the issues being discussed.

For an in-depth content analysis of the podcasts, a qualitative method was applied. Content analysis was used to examine podcast content, identify key terms, and highlight major trends in neurotechnology.

At the first stage, 4 video podcasts were converted into audio files. Using «Otter.ai» program, converted audio file podcasts were transcribed. Program «AntConc» was conducted to calculate word frequency and generate concordance lists. The results confirmed the frequency of key terms identified through KWIC (Key Word in Context) and provided additional data validation. The KWIC method allows us to identify key terms such as: nanophotonics, bionics, settleretics, cyborgization, exoskeletons, and others.

The study identified four subframes: «Cognitive technologies», «Bioengineering and neurointerfaces», «Neurotechnologies in education», and «Phygital interfaces».

These subframes were determined based on the frequency of key topics and their role in discussed topics.

Additionally, discourse analysis was applied to examine the stylistic features of the podcast participants' speech, highlighting the use of borrowings, English loanwoards (e.g., «дисрапшн», «софт скиллы») colloquial expressions, and professional jargon. This method made it possible to analyze how language influences audience perception.

Results and Discussion

Using «AntConc» program, we uploaded transcribed podcast texts. As part of our study, we set up «AntConc» program, generating concordance lists with a context window set to ±4 words. The table below presents key terms.

Table 1 – Concordance list of neurotechnology terminology in AntConc program

№	Left context	Keyword	Right context
1	… upon the activation of the photodetector	Nanophotonics	involves a stream of particles…
2	... in each pair of neurons	The brain-computer interface	are accompanied by EEG…
3	... scientific directions of the cybernetic	Bionics	AI systems and many others ...
4	... a new field of research	Cyborgization	including biotechnology, nanotechnology, cybernetics …
5	... technologies such as cloud computing	Biohybrid robotic skin	neural networks, virtual reality, addictive technologies ...
6	... the unfamiliar human-like	Binocular vision	equipping robots with visual organs ...
7	... regarding the possibilities of ICT	Cybersport	computers simulate virtual spaces ...
8	... the purpose of all these devices	Exoskeleton	you don’t work alone, but …

In the presented table, we have shown the key 8 units. However, we were able to analyze more data, thereby identifying 4 directions which we defined as subframes: «Cognitive technologies», «Bioengineering and Neurointerfaces», «Neurotechnologies in education», and «Phygital Interfaces». The term ‘phygital’ is an example of contamination, formed by the blending of the words «physical» and «digital». Phygital describes an approach that integrates the digital and physical worlds.

The next stage of modeling involves identifying smaller slots that the subframes divided into. Figure 1 presents the frame model of the concept ‘Neurotechnology’.

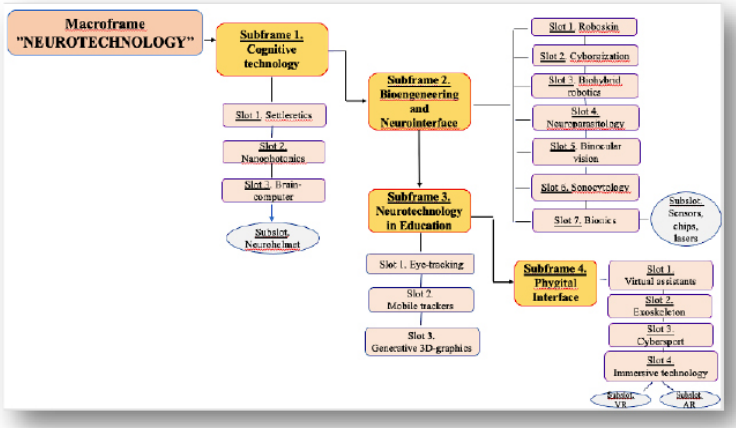


Figure 1 – Frame model of the concept Neurotechnology

In the result of the proposed frames and their slots, we highlighted the interconnections between various technologies and their applications across various aspects of life. All subframes are connected by a common aim of enhancing human cognitive, physical, and educational capabilities through the integration of biotechnology and neurotechnologies.

Subframe 1: «Cognitive Technologies» includes 3 slots: Slot 1 «Settleretics», Slot 2 «Nanophotonics», Slot 3 «Brain-Computer Interface».

Cognitive technologies represent a field focused on improving mental and neurophysiological functions. Three key disciplines are identified here. Settleretics explores the ethical aspects of the interaction between technology and the brain, while nanophotonics and brain-computer interfaces are closely related to the use of nanotechnologies and the creation of neuroplatforms to enhance cognitive abilities.

Subslots such as «neurohelmet», «sensors, lasers» in these fields reveal the potential for improving human-technology interaction, for example, through the use of sensors and neurochips to enhance perception or information processing by the brain.

Subframe 2: «Bioengineering and Neurointerfaces» consists of 7 slots: Slot 1 «Cyborgization», Slot 2 «Sonocytology», Slot 3 «Robo-skin», Slot 4 «Neuroparasitology», Slot 5 «Biohybrids Robotics», Slot 6 «Bionics», Slot 7 «Binocular Vision».

The subframe «Bioengineering and Neurointerfaces» expands on this theme, focusing on the integration of biological and technological systems. Cyborgization, which involves the fusion of humans and technology, creates new opportunities for enhancing human functions.

The application of biocompatible materials, in combination with neurointerfaces and biohybrids robotics facilitates the development of synthetic systems designed to augment both cognitive and physical human abilities. Additional slots, such as sonocytology and neuroparasitology, provide an in-depth perspective on the interaction between biology and technology, exploring how external factors, such as parasites or sound waves, can influence the human organism.

Subframe 3: «Neurotechnologies in Education» is represented by 3 slots: Slot 1 «Eyetracking», Slot 2 «Mobile Trackers», Slot 3 «Generative 3D Graphics».

The subframe «Neurotechnologies in Education» illustrates the application of cognitive and bioengineering technologies in educational processes. The use of technologies such as eyetracking, mobile trackers, and generative 3D graphics aims to enhance the effectiveness of learning, monitor the educational process, and adapt materials to the individual needs of students. These tools enable the tracking of students' attention, analyzing their interaction with learning content, and creating more dynamic educational environments.

Subframe 4: «Phygital Interfaces» includes 4 slots: Slot 1 «Immersive Technologies», Slot 2 «Virtual Assistants», Slot 3 «Esports», Slot 4 «Exoskeleton».

Phygital interfaces reflect the integration of digital and physical worlds, enabling the creation of new forms of interaction with reality. The slot «Immersive Technologies» includes subslots «NeuroVR, NeuroAR» (Neuro Virtual Reality, Neuro Alignment Reality), representing an extension of virtual reality with neurophysiological adaptation, allowing for deeper interaction with digital worlds.

Virtual assistants fasilitate daily tasks, improving quality of life through digital interactions. E-sports and exoskeletons, in turn, are focused on enhancing physical abilities, enabling new levels of human activity and interaction with the physical environment.

Thus, all subframes and their slots are interconnected through the concept of integrating biotechnology, cognitive technologies, and interfaces aimed at improving human capabilities across various domains: from cognitive functions and education to physical abilities and daily interaction with the world. The interaction of these technologies opens new horizons for the transformation of human experience and potential in the future.

Ethics plays a crucial role, as working with living organisms and the human brain is always associated with risks, including potential for invasion in personal life and consciousness.

In cognitive technologies, issues of safety and human autonomy arise when using brain-computer interfaces and nanophotonics. In bioengineering and neurointerfaces, it is essential to consider the moral aspects of the fusion of humans and technology, as well as the protection of personal identity.

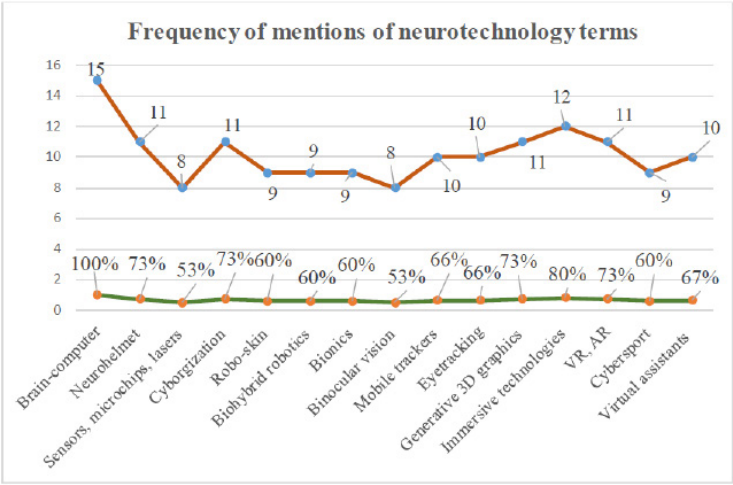
Neurotechnologies in education highlight issues about privacy and the manipulation of student data, while phygital interfaces raise questions about the impact of technology on reality perception and accessibility for different social groups. All of these issues require strict ethical control to prevent abuse and protect human rights.

Using quantitative methods, we identified key terms and their frequency of usage within the context of the discussed topics. As a result of the analysis, the most frequently used terms were highlighted. Diagram 1 and Table 2 display the number of occurrences and the percentage of the terms.

Table 2 – Frequency of mentions of neurotechnology terms

№	Terms	Occurrences	Percentage
1	Brain-computer	15	100 %
2	Neurohelmet	11	73 %
3	Sensors, microchips, lasers	8	53 %
4	Cyborgization	11	73 %
5	Robo-skin	9	60 %
6	Biohybrid robotics	9	60 %
7	Bionics	9	60 %
8	Binocular vision	8	53 %
9	Mobile trackers	10	66 %
10	Eyetracking	10	66 %
11	Generative 3D graphics	11	73 %
12	Immersive technologies	12	80 %
13	VR, AR	11	73 %
14	Cybersport	9	60 %
15	Virtual assistants	10	67 %

Diagram 1 – Frequency of mentions of neurotechnology terms



The data presented in the diagrams illustrate the frequency of key terms, highlighting their significance within the context of the discussed topics. This emphasizes the relevance of each term in the analyzed podcasts and demonstrates their connection to various subframes.

The term «Brain-Computer» (15 occurrences, 100 %) points out the interaction between the brain and technology, a topic that remains highly relevant in society. The terms «Cyborgization» (11 occurrences, 73 %) and «Bionics» (9 occurrences, 60 %) are associated with the process of transforming a living organism into a cyborg, raising ethical questions. According to the podcast's author, there are already several sufficient devices made from biocompatible materials available on the market.

Immersive technologies (12 occurrences, 80 %) include subslots of Virtual Reality (VR) and Augmented Reality (AR). The term «immersive» in English translates to «presence» or «immersion», refers to the engaging experience. In the discussed podcasts there were examples of how these technologies are applied in the education process.

As shown in Diagram 1, the subframes used in the podcasts vary in structure and slot filling. The filling of the slots depends on the development of the industry and the specific direction.

The subframes «Bioengineering and Neurointerfaces» and «Phygital Interfaces» are relatively stable, while others like «Neurotechnologies in Education» and «Cognitive Technologies» subframes, could be influenced by the

application of new materials and devices, potentially driving the development of programs using neurotechnologies.

Moreover, the analysis of the podcasts identified a conversational style, avoiding formalities, which made the discussion more accessible to a broader audience. The hosts and the podcast authors frequently used abbreviations and English loanwords in their speech. For instance, guest Emer Yu. A. [13] uses the word «соцгум» an abbreviation derived from «социальные гуманитарные науки» and «соцгум-инжиниринг» to refer to «социальная гуманитарная инженерия». The phrase «гибридный мир» is substituted with the word «digital».

Podcast author D. Zakharkin [14] also frequently uses English loanwords in his speech. For example, when describing skills, he uses «софт скиллы» and «хард скиллы» which refer to «soft skills» as flexible skills as technical or «hard skills» professional skills. To refer to the field of science and technology related to neural networks, the term «neuronet world» (нейронет мир - мир нейронных сетей) is used.

Instead of the Russian equivalent «разрушение» the podcast authors use «Disruption» (as in «это такой дисрапшн ...»), «поинты» instead of «point of view», «коннект» instead of «connection», and «метавёрс» in the meaning of «meta universe».

However, despite the conclusions drawn based on the podcasts, it should be noted that the number of podcasts analyzed does not provide a complete picture of the topics discussed. In the future, additional podcasts will be included for a more in-depth and comprehensive analysis.

Conclusion

Based on the analysis of the collected mateial, the following conclusions were drawn. The study revealed that the development of a frame model in the field of neurotechnologies, using podcasts as a basis, forms a multi-layered framework where subframes and slots are interconnected.

In accordance with the set research aim, a frame model was developed, with slots and subslots detailing subframes. All 15 podcasts were transcribed, key terms were identified through the KWIC method, and the frequency of term usage was determined.

The frame model allowed us to organize data on neurotechnologies, highlighting the main areas of their development and their significance in the contexts under study. The presented diagram illustrates their importance, providing a deeper understanding of which aspects of these technologies capture the listeners' attention.

Terms such as «Brain-Computer», «Immersive Technologies», «Cyborgization» and «Phygital» reflect a growing interest in the interaction of

technologies with human life. Ethical issues remain a central focus of the research, as they are directly linked to the implementation of neurotechnologies in society.

The results of this analysis offer new opportunities for discussions on the future of technology and its impact on society. Additionally, this research provide a foundation for further research, that is the inclusion of new podcasts and additional terms for a more comprehensive understanding of the evolution of neurotechnologies.

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ФРЕЙМ «НЕЙРОТЕХНОЛОГИЯ», ПОДКАСТТАРДАҒЫ МАҢЫЗДЫЛЫҒЫ МЕН РОЛІ

Бұл мақалада «Нейротехнология» тақырыбын қамтитын подкасттар зерттеліп, осы саладағы негізгі бағыттар мен

ұғымдарды құрылымдауға көмектесетін фреймдік модель жасау мақсаты қойылған. Зерттеу барысында сандық және сапалық әдістер, соның ішінде дискурстық талдау, контент талдау және KWIC әдісі, сондай-ақ «AntConc» бағдарламалық құралдары қолданылды.

Зерттеу нәтижесінде фрейм 4 субфреймммен ұсынылды: когнитивті технологиялар, биоинженерия және нейроинтерфейстер, білім беру саласындағы нейротехнологиялар, фиджитал-интерфейстер («фиджитал» физикалық және цифрлық әлемдерді біріктіру) және олар слот, субслоттарға бөлінді.

Бұл зерттеудің жаңашылдығы – нейротехнологиялар саласындағы лексикографиялық аспектідегі алғашқы фреймдік модельді ұсынуында. Бұрынғы уақытта осындай модельдер басқа салаларда қолданылғанымен, лексикография мақсаттарына бейімделуі өзірленбеген.

Зерттелген подкасттар материалды ұсынудың ауызша стилін көрсетеді, онда англицизмдер, сөздердің қысқартылуы, кірме сөздер және күнделікті өмірден мысалдар қолданылған. Бұл ақпаратты кең аудиторияға қолжетімді етеді. Сонымен қатар, осы технологиялардың қоғамға, денсаулыққа және білімге әсер ететін этикалық аспектілері де қарастырылған.

Зерттеу мамандарға да, қазіргі заманғы технологияларға және олардың қолданылуына қызығатын жалпы аудиторияға да пайдалы болады. Алдағы уақытта зерттеу нәтижелері талқыланған тақырыптарды тереңірек және жан-жақты зерттеу үшін қосымша подкасттарды қосу қажеттілігін көрсетті.

Кілтті сөздер: когнитивті технологиялар, биоинженерия, фиджитал, нейроинтерфейс, нанофотоника, киборгизация.

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ФРЕЙМ «НЕЙРОТЕХНОЛОГИЯ», РОЛЬ И ЗНАЧЕНИЕ В ПОДКАСТАХ

В данной статье исследуются подкасты, освещающие тему «Нейротехнология» с целью создания фреймовой модели, которая организует ключевые направления и концепции в этой области. Для анализа использованы как количественные, так и качественные методы, включая дискурс-анализ, контент-анализ и метод KWIC, а также программное обеспечение «AntConc».

В результате исследования фрейм представлен четырьмя субфреймами: когнитивные технологии, биоинженерия и нейроинтерфейсы, нейротехнологии в образовании и фиджитал-интерфейсы (где «фиджитал» означает слияние физических и цифровых миров), которые далее подразделяются на слоты и подслоты.

Новизна данного исследования заключается в представлении фреймовой модели нейротехнологии с лексикографической точки зрения, что является первым подходом в данной области. Ранее аналогичные модели применялись в других сферах, однако их адаптация для лексикографических целей не была разработана.

Анализируемые подкасты демонстрируют разговорный стиль подачи материала с использованием англицизмов, заимствований, сокращений и примеров из повседневной жизни, что делает контент доступным широкой аудитории. Также рассматриваются этические аспекты, связанные с влиянием технологий на общество, здоровье и образование.

Данное исследование будет полезно как специалистам, так и широкой аудитории, интересующейся современными технологиями и их применением. Полученные результаты показывают необходимость дальнейших исследований, включая дополнительные подкасты, для более глубокого и всестороннего анализа обсуждаемых тем.

Ключевые слова: когнитивные технологии, биоинженерия, фиджитал, нейроинтерфейс, нанофотоника, киборгизация.

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