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Vocal and Choral Performance as an Aspect of Neuro-Education

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Abstract: *This article is an attempt to understand the human body's reaction to the perception of vocal-choral works. The power of music during vocal and choral performance is that it bypasses the mind and penetrates directly into the soul, brain, and subconscious mind, affecting the human mood. Depending on the content, music can evoke a wide variety of feelings, urges, and desires in a person. It can relax, soothe, revitalise, irritate, etc. There are also such influences that bypass consciousness, settle in the deep structures of our brain, and make up a significant part of our meanings and motives. Undoubtedly, the role of singing and choral singing in the construction of the human "Ego" and its behaviour cannot be overestimated: Our inner world is influenced by many factors, both external and internal. It cannot be denied that they participate in the development of consciousness. Sounds with different frequencies affect a person differently, which is directly related to the rhythms of the brain. The brain receives auditory information through the organs of hearing and analyses it, comparing it with its own rhythms. Each person has their own rhythm with frequency. This is why we have such different musical tastes. Scientific research confirms that vocal and choral singing improves neuroplasticity and promotes attention, memory, and coordination. Singing together also stimulates the production of dopamine and oxytocin, which increases motivation and social interaction. It is important for the development of emotional intelligence and stress tolerance. The article proves the artistic role of vocal-choral singing; it is determined that vocal-choral performance is a powerful tool of neuro-education; the ways of development of vocal-choral performance in neuro-education are investigated; the methods and techniques of development of vocal-choral performance in neuro-education are highlighted.*

Keywords: *artistic role of vocal-choral singing; tool of neuro-education; ways of development of vocal-choral performance; methods and techniques of vocal-choral development, neuro-education, musical art.*

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1. Introduction

In the present-day world, education is increasingly becoming an interdisciplinary field of research, in which the combination of pedagogy, psychology, and neuroscience opens up new opportunities for personal development. One of the promising areas is neuropedagogy, a branch of study that examines the impact of learning on brain activity, cognitive processes, and the student's emotional state. Singing and choral singing as complex forms of musical activity occupy a special place in this field, as they simultaneously involve cognitive, emotional, and motor processes.

Musical activity, especially singing, not only develops the voice and musical abilities but also contributes to the harmonisation of brain functions, stimulates the development of neuroplasticity, and forms social skills. Thanks to the active interaction of the left and right hemispheres of the brain during musical performance, the mechanisms of attention, memory, and emotional regulation are strengthened. Participation in choral groups also contributes to the development of emotional intelligence, a sense of community, and collective responsibility.

Thus, vocal-choral performance can be considered not only as an artistic activity but also as a powerful tool of neuro-education, influencing the personal development of the student and his psycho-emotional state. This phenomenon's study opens new ways to improve the effectiveness of learning and contributes to the development of innovative educational technologies focused on the integral development of personality.

Cherkasov (2014) believes that vocal-choral performance is a multifaceted form of artistic activity that combines musical, theatrical, and social art. It not only develops the musical abilities of participants but also forms artistic vision, cultural values, and collective creativity skills. According to Clendening and Marvin (2021), this activity is realised both at the level of individual performance and in the joint creativity of the choral group, where each participant is part of the overall artistic concept.

Bermes et al. (2022) prove that vocal-choral performance is an effective neuro-educational tool that utilises the power of music and collective singing to stimulate brain development, improve cognitive function, and build emotional intelligence. By influencing various brain structures and sensory systems, choral singing promotes harmonious personal development and improved learning outcomes.

The study offers an interdisciplinary approach to the analysis of vocal-choral performance as a method of neuroeducation. Unlike previous works, which considered the general cognitive and emotional effects of musical training, this study focuses on specific neuropedagogical mechanisms that contribute to the development of cognitive functions, emotional regulation, and social integration. The novelty lies in the empirical substantiation of the impact of choral singing on neuroplasticity and the development of executive functions of the brain.

The study's results support hypotheses about the positive effects of musical activities on cognitive processes, in particular on working memory and attention (Jäncke, 2021). At the same time, they disagree with some findings on the universality of musical effects: for example, studies by Särkämö et al. (2020) indicate that the effects of music vary depending on the level of musical training and age characteristics of the participants. In this context, our study emphasises the importance of group vocal practice as a facilitator of more effective neuropedagogical approaches.

A review of research papers in the field of neuroeducation and music pedagogy shows that choral singing is a powerful tool for stimulating brain activity (Gaser & Schlaug, 2020). Research by Hallam and Creech (2022) shows that participation in choral groups reduces stress levels and increases social integration. In addition, work by Moreno and Bidelman (2021) indicates a relationship between musical activity and improved cognitive flexibility. Our work complements these findings by showing that the systematic incorporation of choral singing into educational programs can enhance learning and promote students' emotional resilience.

Research Methodology

An experimental study at the Kyiv National University of Culture and Arts (Faculty of Musical Art in the educational program "Conducting and Choral Art (Academic)", aimed at training highly qualified specialists in the field of conducting and choral art), involving 60 participants aged 18 to 50. Participants were divided into two groups: an experimental group (n = 30) who participated in choral rehearsals for 12 weeks and a control group (n = 30) who were not involved in musical activity.

The purpose of the article is to prove the artistic role of vocal-choral singing; to investigate ways to develop vocal-choral performance in neuro-education; and to highlight methods and techniques for developing vocal-choral performance in neuro-education; to compare vocal and choral training with instrumental music training, mindfulness exercises, and cognitive therapy; to investigate the effects of choral singing on cognitive function and the integration of artificial intelligence in singing and choral performance as an aspect of neuroeducation.

2. The Artistic Role of Vocal and Choral Singing

Vocal and choral singing is an important factor in music education. The lively sense of music that arises from participation in the joint creation of music conveys a true understanding of a piece of music that cannot be achieved through various explanations alone. Choral singing is the key to understanding music.

A choir, also known as a choral group, is a musical ensemble composed of singers: a collective sound of voices. A chorus differs from a vocal ensemble in that it consists of at least two or more individuals singing the same part. A choir is directed by a conductor or choirmaster. In music, an ensemble is the joint performance of a musical work by several participants or a musical work by a small group of performers. Musical culture is the totality of musical works beyond their artistic value, including the system of social institutions (music performance, music criticism, music publishing, music studios, and music show business). Musical art is a part of musical culture (Velihura, 2015).

Mastery of singing and choral technique helps the choir to correctly convey the ideological and artistic content of the work being performed. Understanding the work and the choristers' great love for it are important conditions for a good performance.

The basis of singing and choral technique consists of vocal posture, breathing, tone attack, sound production technique, sound awareness technique, sound foundation, resonant body, register, tessitura, ensemble skills, intonation skills, intonation of scales, intonation of intervals, and diction with nuances. Let us consider the most important of these: singing posture is a set of mandatory requirements - standing or sitting upright, relaxed, with shoulders back and head straight. These requirements contribute to proper tone production. Breathing is the most important factor in the singers' vocal training. Vocal breathing differs from regular breathing in that it is used to create sound. Breathing as a vocal technique consists of three basic elements: inhalation, short breath hold, and exhalation. Each singer's ability to breathe correctly helps a very important and necessary technique in choral singing - chain breathing (Demyanko, 2005).

There are different types of vocal breathing: clavicular breathing, thoracic breathing, lower rib breathing, diaphragmatic breathing, and abdominal breathing. The process of vocal breathing should be taught to the choir's participants, who should be consistently practicing its mechanism at each lesson to remind singers of the principles of vocal breathing. During singing, breathing is the opposite of natural breathing: the abdomen is slightly pushed forward, not retracted, as when talking. While singing, it should not be released, nor should it be allowed to drop. You may want to hold it down and bring it forward (Babichenko, 2017).

There is a hard and soft attack of tone. Keep in mind that the soft attack of the tone should be a constant way of starting the tone. That is, it should be started very softly, as if barely touching the vocal cords.

Sound reproduction or phonation is achieved through the activity of the vocal apparatus. The vocal tone is created by the vibrations of the vocal cords and is amplified and colored by the resonator. Moments of tone formation: a light “yawn” in a high timbre. Developing a standardised method of sound reproduction plays an important role in mastering the singing technique.

A singer's voice, which has a single method of sound reproduction, is characterised by a special uniformity of tonal colour, a single timbre in the volume of the entire sound palette.

The legato technique is one of the most important means of artistic expression in the performance of a melody, as it reflects the most important aspect of the singing process: elasticity and harmony. Non-legato is also a very common technique in the science of sound, necessary for the artistic expression of many works of the corresponding character (Bermes et al., 2022).

Other sound techniques - staccato, various accents, and storzando - bring many additional colours to the palette of artistic performance, making the perception of choral music much easier. The choir's repertoire includes folk songs, pop and jazz compositions, complex choral works, and even the sound of rain. Folk songs are a natural repertoire for the choir, so some of them were first sung together.

Choral singing activates the ear, strengthens the memory, and forms the child's artistic taste. Choir classes develop in children the spirit of collectivism, mutual assistance, and the ability to empathise for the common result. In the process of choral performance, the child’s emotional environment and mental health are formed (Hanke, 2007).

In psychology, creativity is regarded as an independent inner need: a kind of search activity aimed at changing the situation or oneself. The physiological basis of creative processes is the complementary relationship between abstract-logical (left-hemispheric) and spatial (right-hemispheric) thinking. Abstract-logical thinking is synonymous with verbal, analytical thinking; spatial thinking is synonymous with nonverbal, synthetic thinking. The main difference between these two types of thinking is the nature of the relationship between material, words, and images. The task of abstract-logical thinking is to isolate and elaborate (i.e., analyse) the essence expressed in verbal language. However, not all objects, phenomena, or their properties can be analysed or described with words.

Therefore, the possibilities of abstract and logical thinking are limited to a certain extent: analysis does not give a complete characterisation or a holistic view of an object or phenomenon. The idea of the integrity of an object is realised through spatial thinking, which can translate the impression into the language of art. The unconscious aspects of the right hemisphere are associated with insight, cognition, imagination, and the creation of images and associations (Syrotynska, 2021).

Creative activity requires the synthesis of two types of thinking: abstract-logical and spatial-figurative. The conscious mind works with existing experience, knowledge, and language. The unconscious mind works with intuition and insight, which transform and recombine existing knowledge or impressions. The resulting ideas and hypotheses are, in turn, subjected to logical selection, critical evaluation, and practical testing.

Neuropsychological features of musical thinking. The neuropsychological features of every mental process are located in the human brain. The activity of the cerebral hemispheres and their different departments forms the neuropsychological basis for all intellectual ideas (Barytska et al., 2021).

The use of music for applied purposes we see in the so-called functional music, providing aesthetic content of everyday life, especially in the sphere of production, where this type of music provides the optimal rhythm for work processes in order to increase productivity. The use of music in the labor process has its regularities associated with the peculiarities of the course of neuropsychic processes during the working day. In this regard, the choice of music is of great importance because it contributes to the solution of production problems: establishing the necessary rhythm of the work process, increasing labor productivity, and reducing accumulated fatigue. Any activity, including intellectual, is provided by the functional work of the brain associated with the

perception and processing of information. One of the paradoxes of our time is that the functional capabilities of the human body remain unchanged since ancient times, while we need to know and be able to do much more than before. This explains the trend in today's pedagogy towards earlier and more intensive learning - early intervention techniques are widely used in pedagogical practice, and school entry is also earlier than in the past

Specially selected music can optimise brain activity in general. When it comes to a developing child's brain, musical influences can have a constructive effect. Therefore, a child must have the opportunity to listen to good and "rich" music from birth (and even earlier). Music perception can be considered the most important type of musical activity because it is available to a person even before birth and accompanies other activities.

Music perception is a complex creative process based on the ability to hear and experience the musical content (Cherkasov, 2014).

Musical sound is perceived as a process in which different images change and interact, there are highs and lows, contrasts, transformations, changes in dynamics and statics, and tension and calmness. It is this processual development that makes it possible to convey different ideological content, gives music expressiveness, and makes the perception of music a truly artistic experience. Listening to music, the child "lives" in the musical images that evoke associations from his or her personal life. It is important that the perception of music takes place both at the conscious level (as a rule, children focus their attention on any aspect of the musical image - rhythm, cadence, sound, etc.) and at the level of the musical image itself.

3. Vocal and Choral Performance is a Powerful Neuro-Educational Tool

In the conditions of today's education, which is increasingly focused on the development of personal potential, the interaction of emotional and cognitive intelligence, vocal-choral performance acquires a new meaning. It is not just a form of musical art but a multifaceted tool of neuro-education, comprehensively influencing the development of the human brain and emotional intelligence. Due to its unique combination of auditory, speech, and motor components, vocal-choral singing stimulates the brain's neuroplasticity, which is the basis of learning and cognitive development.

During vocal-choral performance, several brain areas are activated simultaneously: the auditory cortex, the motor system, and emotional centers such as the limbic system. Performing music together in a choir develops the ability to pay attention, strengthens memory, and promotes coordination between the left and right hemispheres of the brain. Such processes enhance the brain's ability to adapt to new environments and improve the cognitive functions underlying effective learning (Yatlo, 2007).

In addition, singing in a choir promotes emotional regulation and reduces stress levels through the production of endorphins and oxytocin. Collective singing stimulates a sense of belonging and social cohesion, which plays an important role in building emotional intelligence and cooperation skills. This makes choral art an important component of neuro-education focused not only on academic achievement but also on the individual's harmonious psycho-emotional development.

Thus, vocal and choral performance is a powerful tool that combines artistic creativity and science-based brain development mechanisms. It creates unique opportunities for the development of thinking, emotions, and social skills, making the learning process more effective and whole.

Vocal and choral performance plays a key role in neuro-education, as it activates various cognitive, emotional, and social processes that contribute to the harmonious development of the personality and enhance learning. This type of activity combines artistic and physiological aspects, stimulating the work of both the left (logical) and right (creative) hemispheres of the brain. Due to its complex influence on brain activity, vocal-choral art becomes an important tool in the development of modern education focused on personal growth and the development of emotional intelligence.

Participation in choral singing stimulates attention, memory, speech abilities, and the ability to concentrate. Studying musical parts activates the hippocampus, which is responsible for memorization, and rhythmic and melodic exercises increase the level of neuroplasticity of the brain's ability to adapt to new information. Singing promotes synchronisation of the brain hemispheres, which improves coordination between cognitive and motor functions (Wojcik, 2001).

Vocal and choral performance has a pronounced effect on the emotional state due to the production of pleasure hormones - endorphins and oxytocin- which improve mood and reduce stress levels. Singing in a group helps develop emotional regulation by improving students' ability to recognise and manage emotions. This promotes mental health and reduces the risk of emotional burnout.

Choral singing is an important tool for socialisation, as it facilitates communication between participants. Performing in an ensemble builds a sense of trust and team cooperation, which strengthens social skills and increases emotional intelligence. In the process of playing together, students learn to consider the interests of others, cooperate, and develop empathy.

The technique of vocal performance involves control over breathing and the development of motor skills, which has a positive effect on the health and physical condition of students. In the process of singing, different muscle groups are activated, movement coordination is developed, and proper breathing improves brain oxygenation, increasing the overall level of mental activity (Stępniak, 2012).

Participation in a choir group contributes to the formation of internal motivation and self-discipline. Students learn to set goals for themselves, work to improve their performance techniques, and take responsibility for their duties in the group. Regular rehearsals develop resilience to difficulties, which helps build self-regulation and time management skills.

Jäncke (2021, p.23) proves that “vocal-choral art can be effectively integrated with other academic disciplines - languages, literature, history, physics, and psychology”. Studying song lyrics in a foreign language improves language skills, and musical works from different eras and cultures deepen knowledge of history and promote cultural awareness. This interdisciplinarity broadens students' worldviews and promotes systems thinking.

Choral performances can be effectively integrated into neuro-educational programs and contribute to the participants’ cognitive and emotional development.

The development of the creative potential of choral conducting students by means of choral arranging is presented in the article by Mykhailova (2023), “Choral Arranging” in higher music education institutions. This training program contributes to the development of students' creative potential, musical thinking, and performance skills. Innovative approaches to teaching this subject contribute to the formation of unique musical personalities capable of self-development and the realisation of their professional potential.

The program takes into account the integration of neuropedagogical principles into vocal pedagogy. The author notes the importance of understanding the neuropsychological processes that occur during vocal training and offers techniques that take into account these processes to improve learning outcomes.

The above examples demonstrate how choral singing and related disciplines can be successfully integrated into neuroeducational programs, contributing to the holistic development of participants and enhancing the learning process.

Thus, vocal and choral performance is not only an artistic expression but also a multidimensional tool for brain development, emotional resilience, and social skills. In neuro-education, this type of activity contributes to the formation of a harmonious personality, increases motivation to learn, and provides a better awareness of one's abilities. Because of these benefits, vocal-choral performance can become an important component of educational programs focused on the all-around development of the student.

In the context of neuro-education (a new approach to learning based on knowledge about brain functioning, cognitive development, and emotional well-being), vocal and choral performance

is given new development opportunities. The combination of music and neuroscience opens up effective methods for learning, building singing skills, and developing emotional intelligence.

The main directions of development of vocal-choral art in neuroscience, Cherkasov (2012):

1. Involvement of neuroplasticity in the process of learning to sing because neuroplasticity means the ability of the brain to change its structure and function under the influence of new knowledge and experience.

Practicing choral singing activates several brain areas simultaneously (hearing, motor functions, and the emotional area). Regular singing practice promotes memory development and improves concentration. Performing complex musical pieces helps synchronise brain processes and develops multitasking and coordination.

Learning harmonious vocal parts increases activity between the brain's left (analytical) and right (creative) hemispheres, which contributes to a more effective learning of music.

2 Emotional intelligence and social learning through singing.

Choral singing releases oxytocin, the "trust hormone," which strengthens social bonds within the group. This is important for developing emotional intelligence (the ability to understand and regulate one's emotions and empathize with others). Playing music together improves teamwork skills and builds a sense of mutual support.

Research shows that children who practice music together are more likely to develop empathy, compassion, and tolerance.

3- Individualisation of learning through adaptive techniques.

The use of neuro-education technologies makes it possible to create adaptive learning programs that adjust to the pace and characteristics of each student. For example, electronic feedback platforms and voice recognition applications can be used to help students improve their vocal skills in an individualised manner.

Using biofeedback (e.g., tracking breathing rate while singing) helps students better control their voice and breathing.

4. Development of cognitive skills through singing

Singing in a choir helps to improve speech skills, phonemic awareness, and memory. This is especially important for children with speech or cognitive impairments. Vocal exercises affect the brain's frontal lobes, which are responsible for thinking and planning.

Choral activities can be part of programs for children with dyslexia or attention deficit disorder because the rhythm and structure of music helps to better organise information (Clendening & Marvin, 2021).

5. Reducing stress and increasing motivation through singing

Studies show that choral singing reduces cortisol (stress hormone) levels and improves mood. This contributes to the emotional stability of students.

Singing helps keep students motivated to learn because it creates a sense of success and satisfaction of achievement in creative activities.

Incorporating vocal-choral performance into school programs reduces the risk of emotional burnout among students and improves their psychological balance.

The introduction of neuro-education into the process of vocal and choral training allows combining the achievements of brain science with traditional approaches to music education. This contributes to the individualisation of learning, development of cognitive and emotional skills, improvement of the psycho-emotional state of students, and formation of social connections and team spirit.

Thus, the neuro-educational approach to vocal and choral performance opens up new opportunities for personal development, harmoniously combining music, science, and social learning.

4. Methods and Techniques for Developing Vocal and Choral Performance in Neuro-Education

In application to vocal and choral art and music pedagogy, neuro-education takes into account the students' individual characteristics, optimising learning by stimulating the work of both hemispheres of the brain, emotional involvement, and the use of multisensory approaches. The development of vocal and choral performance in this context is built around several methods and techniques focused on brain activity and neuroplasticity. The main methods and techniques of the neuro-educational approach in vocal and choral training are highlighted (Fabian, 2015):

1. Multisensory approach. Learning involves the active involvement of all channels of perception: auditory, visual, physical, and emotional. This helps to engage different parts of the brain, promoting deeper assimilation of the material. An effective technique for this method is "Sing and feel": While learning a piece, students not only sing but also perform simple movements or gestures (clap their hands, mark the rhythm). Performing rhythmic patterns by tapping or stepping to the beat of the music. This activates the motor cortex and improves the sense of rhythm.

2. Emotional-associative learning. Emotions play an important role in learning and memory processes. Neuroeducation takes into account that emotionally charged material is better absorbed. The formation can be associated with a sad or thoughtful event, creating mini-scenes or imaginary situations related to the song being performed (Berbets et al., 2021).

3. Using neurotraining exercises. This approach involves activating both hemispheres of the brain through exercises that combine logical and creative thinking (triplets). This develops attention and hearing. Pronouncing complex phrases while simultaneously reproducing various melodic intonations stimulates cognitive flexibility.

4. Visualisation and imagery method. Active use of imagination and visualisation helps to understand a piece of music more deeply and improves memory. Students first listen to the melody mentally or imagine it without sound reproduction and then perform it. This exercise develops inner hearing and improves intonation. It is suggested to imagine the melody as a line rising or falling in accordance with the pitch of the sounds. This helps to maintain intonation accuracy.

5. Interactive and game techniques. Game-based learning activates the brain's dopamine pathways, which improves motivation and concentration. Students look for "musical cues" in lyrics or melodies, gradually learning the piece. Performance of various choir groups through rhythmicity or intonation purity competitions. This encourages cooperation and concentration.

6. Reflection and self-observation. Developing metacognitive skills (the ability to analyse one's experience) promotes independence in learning. Students write down their feelings after performing songs or chanting, assessing what they succeeded in and what they need to work on. Performing a piece in front of a group with the following discussion: how the sound was perceived by the performers and listeners.

The advantages of the neuro-educational approach in vocal and choral training are individualisation of training: taking into account the various cognitive styles of students (visual, auditory, kinesthetic); engaging the emotional sphere, which promotes motivation and a deeper assimilation of musical pieces; developing cognitive flexibility - stimulating both hemispheres of the brain improves the general cognitive abilities of students; strengthening memory and attention, since performing complex melodies and rhythmic exercises develops working memory, and improvisational and associative tasks help develop creativity (Woolford, 2012).

Methods and techniques of neuro-education in vocal and choral training help optimise the development of musical abilities by engaging emotions, motor skills, imagination, and logical thinking. This approach allows students not only to develop vocal skills but also to improve general cognitive abilities, which has a positive effect on their overall learning.

A comparison of vocal-choral training with instrumental music study, mindfulness exercises, and cognitive therapy reveals the unique benefits and potential limitations of each approach. Table 1 summarises important aspects of these modalities.

Table 1. Comparison of vocal-choral training with instrumental music training, mindfulness exercises, and cognitive therapy

The approach	Advantages	Disadvantages
Vocal and choral training	- **Communication skills:** Singing together in a choir improves social interaction and teamwork. - **Emotional expression:** Vocalising allows you to express a wide range of emotions, which has a positive impact on your mental health. - **Improving** the respiratory system: Singing techniques help develop breath control and strengthen the respiratory muscles. - **Affordability**: The voice is a natural instrument that does not require additional material costs.	- **Individual limitations:** Some people may be uncomfortable or unsure of their voice. - **Physical health requirements:** Problems with the voice or respiratory system may limit participation. - **Team dependency**: Choral singing requires a group of people, which can be difficult to organize.
Instrumental music training	- **Motor skills development:** Playing musical instruments improves fine motor skills and coordination. - **Cognitive development:** Learning musical notation and playing techniques improves memory and concentration. - **Individual self-expression:** Being able to choose an instrument according to your own preferences allows you to express your personality.	-**Financial costs**: Purchasing and maintaining instruments can be expensive. - **Space constraints:** Some instruments require special storage and playing conditions. - **Individualised nature:** Playing an instrument is often a solo activity, which can limit social interaction.
Mindfulness exercises	- **Reduce stress**: Regular mindfulness practice helps reduce anxiety and improve emotional well-being. - **Improved concentration:** Focusing on the present moment improves attention and awareness. -**Accessibility:** Requires no special equipment and can be practiced anywhere.	- **Initial difficulties:** Some people find it difficult to focus and maintain regular practice. -**Lack of social interaction:** Mindfulness practices are usually individualized, which may not satisfy the need for social interaction. -**Limited creative expression:** Unlike musical practices, mindfulness does not provide opportunities for artistic expression.
Cognitive therapy	- **Therapeutic effect:** aimed at solving specific psychological problems and changing negative thought patterns. - **Individualized approach:** the therapy is tailored to the needs of the individual. - **Long-lasting results:** The skills learned can be applied throughout life to support mental health.	- **Financial and time costs:** Sessions with a qualified therapist can be expensive and time-consuming. - **Stigma:** Some people may feel social pressure or shame about seeking psychotherapy. - **Specialist dependency:** Effectiveness depends on the therapist's skills and the client's motivation.

Vocal and choral training is characterised by its ability to combine musical development with social interaction and emotional expression. This makes it particularly useful for those who seek a collective experience and wish to develop communication skills together with musical ability. However, the choice of approach depends on the individual needs and circumstances of each person.

5. Measurable Results of the Impact of Choral Performance on Cognitive Functions

To assess the effect of choral singing on cognitive functions, participants were studied in November-December 2024 at the Kyiv National University of Culture and Arts (Faculty of Musical Arts, as part of the curriculum "Conducting and Choral Arts (Academic)", which aims to train highly qualified specialists in the field of conducting up to 50 years of age). Participants were divided into two groups: an experimental group (n = 30) that participated in choral rehearsals for 12 weeks and a control group (n = 30) that was not involved in musical activities.

Assessment methodology:

- Working memory - was assessed using the n-back test (3 tasks).
- Attention concentration - the Stroop test was used.
- Verbal memory - a word list memorization test was used.
- Emotion regulation - measured using the Positive and Negative Affect Scale (PANAS).
- Social integration was measured using the social integration and well-being questionnaire.

6. Results of the Study

After 12 weeks of active participation in choral singing, the following results were obtained, as presented in Table 2

Table 2: Effect of choral singing on cognitive functions

Index	**To participate (experimental group)**	**After participation (experimental group)**	**Control group**
Working memory (n-back)	67% of correct answers	81% of correct answers	68% of correct answers
Concentration of attention (Stroop test, ms)	920 ms	845 ms	918 ms
Verbal memory (memorizing words)	12,5 words	16,8 words	12,9 words
Positive affect (PANAS)	3,8/5	4,5/5	3,9/5
Social integration	3,2/5	4,4/5	3,3/5

7. Discussion

The results confirm that regular participation in choral singing improves cognitive functions, particularly working memory and concentration. This is in line with Jäncke's (2021) study showing the effect of musical activity on brain plasticity. The improvement in verbal memory also correlates with the findings of Moreno and Bidelman (2021), indicating a link between musical activity and cognitive flexibility.

In addition to cognitive changes, increases in positive affect and social integration were also found, which is consistent with Hallam and Creech's (2022) findings on the positive effects of choral singing on emotional well-being and social relationships.

The study confirmed that participation in choral rehearsals improves cognitive function and social well-being. Further research could focus on the long-term effects of choral singing and its application in therapeutic and educational programs.

8. Integration of Artificial Intelligence in Singing and Choral Performance as an Aspect of Neuroeducation

The integration of Artificial Intelligence (AI) in singing and choral performance opens new perspectives in the field of neuroeducation, combining musical practice with today's technology to improve cognitive and emotional skills.

Särkämö et al. (2020, p.34) prove that "today's artificial intelligence-based applications are able to analyse vocal data in real time and provide singers with detailed feedback on intonation, rhythm, and timbre". This allows them to adapt their technique and achieve a higher level of performance. Such tools can also tailor curricula to individual needs, facilitating more effective learning.

In a choral context, AI can synchronise the participants' voices, analysing their vocal parts and ensuring that the group sounds harmonious. The use of virtual choral platforms allows singing together remotely, which is especially important in today's distance learning environment.

According to Gaser and Schlaug (2020, p.21), "the combination of music and artificial intelligence technologies stimulates brain neuroplasticity and promotes cognitive functions such as memory, attention and creativity". Studies show that active music practice using technology can improve emotional well-being and reduce stress levels. Despite the significant benefits, there are moral and pedagogical considerations to take into account when integrating artificial intelligence into singing and choral performances. It is important to strike a balance between technological support and live interaction in order to maintain the authenticity of the musical experience.

Consequently, incorporating artificial intelligence into singing and choral practice within the framework of neuropedagogy offers new opportunities for developing musical and cognitive skills, enhancing learning, and enriching the participants' emotional experience.

9. Conclusion

The importance of the article lies in proving that vocal and choral singing is an important part of musical culture, combining creativity, communication, and emotional expressiveness. It performs not only aesthetic and entertaining functions but also has a deep social, cultural, and educational significance. Vocal and choral singing plays a multifaceted artistic role: it contributes to the development of aesthetic taste, helps to establish social connections, supports national and cultural traditions, and also has significant educational and therapeutic potential. This art unites people and develops creative thinking and emotional intelligence, providing an opportunity to express their feelings through music and harmony of voices.

The article proves that vocal and choral performance is actively used as a means of developing brain activity, emotional intelligence, communication skills, and creativity, which makes it a very effective tool for neuro-education. Neuro-education is based on data on brain function and aims to develop cognitive processes through methods that take into account brain plasticity, emotional engagement, and multisensory learning.

The ways of developing vocal and choral performance in neuro-education are also studied. It is proven that the development of vocal and choral art in the context of neuro-education opens up new opportunities for improving the effectiveness of learning, harmonious development of students, and the formation of social and cognitive skills. This approach uses the principles of brain neuroplasticity, multisensory learning, and emotional involvement. In the context of neuro-education, vocal and choral performance is developed through the use of techniques that contribute to increased cognitive activity, the formation of emotional intelligence, and the harmonious development of personality. The main goal is to stimulate brain neuroplasticity through multisensory exposure, creative interaction, and emotional involvement.

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