

UDC 784

DOI: 10.52534/msu-pp1.2025.113

Kseniia Al-Khleifat*

Bachelor of Science

Taras Shevchenko National University of Kyiv

01601, 60 Volodymyrska Str., Kyiv, Ukraine

<https://orcid.org/0009-0002-0354-8744>

The effects of vocal training on the cognitive and emotional development of young children

Article's History:

Received: 09.11.2024

Revised: 03.03.2025

Accepted: 26.03.2025

Suggested Citation:

Al-Khleifat, K. (2025). The effects of vocal training on the cognitive and emotional development of young children. *Scientific Bulletin of Mukachevo State University. Series "Pedagogy and Psychology"*, 11(1), 113-124. doi: 10.52534/msu-pp1.2025.113.

Abstract. The aim of the study was to identify the peculiarities of the impact of vocal education on various aspects of child development. The study examined theoretical approaches to investigating the impact of music and vocal training on brain development, assessed pedagogical methods of vocal instruction, and synthesised statistical data on the significance of music education in fostering emotional intelligence and social adaptation. The research methodology included the analysis of scientific literature devoted to the influence of vocal training on cognitive, emotional and social development of children. Theoretical concepts, empirical research data, as well as comparative analysis of different pedagogical approaches to vocal training were studied in the process of work. Scientific works in the field of neuroscience, psychology and music pedagogy were considered, which made it possible to evaluate the multidimensional impact of vocal education on child development. The results of the study confirmed that vocal training promotes the development of auditory perception, phonemic hearing, memory, attention and speech skills. It was found that children engaged in vocal training showed higher scores in tests of cognitive flexibility, working memory, and analytical ability. In addition, vocal education had a positive impact on emotional development, promoting empathy, social adaptation and self-confidence. Participation in group singing improved children's communicative abilities and reduced anxiety levels. Based on the findings, recommendations were developed to improve the pedagogical practices of vocal training. The practical significance of this study lies in its potential to enhance early childhood education by integrating vocal training as a tool for cognitive and emotional development. The findings provide valuable insights for educators, music instructors, and policymakers, supporting the implementation of evidence-based pedagogical approaches that foster children's auditory perception, linguistic abilities, and social skills. Additionally, the study highlights the importance of interactive and adaptive teaching methods, offering practical recommendations for optimising vocal training to suit diverse learning needs and developmental stages.

Keywords: neurobiology of music; pedagogical approaches; multiple intelligence theory; modern methods; interactivity

*Corresponding author

INTRODUCTION

Research on the impact of music education on children's cognitive and emotional development continues to expand, highlighting its significant role in fostering essential skills from an early age. Vocal training, in particular, serves as a comprehensive developmental tool, integrating cognitive, emotional, and social dimensions. Its relevance is further

underscored by contemporary educational trends that emphasise the importance of holistic learning approaches, making vocal training an essential component in modern pedagogical practices aimed at enhancing children's communication abilities, emotional intelligence, and overall academic performance.



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Studies showed that regular vocal training could have a positive effect on cognitive functions such as memory, attention, and language abilities, and also contributed to the development of emotional intelligence. However, despite the growing body of work in this area, systematised data on the effects of vocal training on children's cognitive and emotional development remained fragmented, necessitating further research on this issue. The need to study this topic has arisen due to the expanding understanding of the role of music education in cognitive development. Studies on the impact of various forms of musical training revealed its positive effects on children's brain activity, but most of them focused on instrumental training, while vocal practice was studied to a lesser extent. Meanwhile, vocal training required the coordination of listening, breathing, articulation and emotional expression, making it a special tool in the formation of cognitive and emotional skills.

Research in this area has covered a wide range of issues. For example, A. Cisneros *et al.* (2023) studied the effects of daily choral singing and creative writing exercises on the cognitive development of primary school children. In their work, the authors found that such activities promoted memory, attention and language skills, especially in children from socially disadvantaged backgrounds. Similar results were demonstrated by J. Bugos *et al.* (2022), who conducted a randomised study to examine the effects of multimodal music instruction on children's executive functions. The study found that children who received music training demonstrated improved cognitive abilities, including working memory and cognitive control.

D.A. Rodriguez-Gomez & C. Talero-Gutiérrez (2022) conducted a systematic review of research papers on the effects of musical training on executive function development. Their study emphasised that regular participation in vocal programs promoted the development of cognitive control and self-regulation, which was particularly important at an early age. At the same time, despite the positive effects identified, the authors noted that there was insufficient empirical evidence to support the unique impact of vocal training compared to other types of music education.

The impact of vocal training on children's emotional development has been analysed in a number of studies. J.S. Blasco-Magraner *et al.* (2021) conducted a systematic review of studies that showed that music lessons contributed to the emotional development of children between the ages of 3 and 12. The authors indicated that regular vocal training increased children's ability to express themselves, improved emotional regulation and social skills. Similar findings were reported by R.C. Plate *et al.* (2024) who investigated the effect of musical training on children's perception of emotional nuances of music. The experiment revealed that children with vocal training experience demonstrated a higher sensitivity to the emotional components of music, indicating the importance of vocal education in the formation of emotional intelligence. From a pedagogical point of view, studies showed that the

effectiveness of vocal training depended on the techniques used. O. Pryadko (2021) studied the influence of musical art on the development of emotional intelligence of primary school children, emphasising the need to use playful and interactive methods. In turn, Y. Zhang (2021) analysed the influence of psychological aspects on the process of learning to sing, emphasising the importance of an individual approach to learning and the elimination of possible psychological barriers.

Practical aspects of vocal training were reflected in the works of R. Hidayat *et al.* (2024), who examined the role of singing method in the development of language skills in young children. The study found that vocal exercises helped to improve diction, articulation and general speech activity. K. Jendrysik (2024) studied methods of building vocal competence in early school-age children, identifying the most effective teaching strategies. For example, D. Li (2023) analysed ways to improve the effectiveness of vocal training in the preschool education system, highlighting key methodological principles that ensured the formation of sustainable vocal skills.

Despite the considerable amount of research in this area, there were still unresolved issues that require further study. In particular, there were gaps in understanding the specifics of the impact of different vocal training methods on the cognitive and emotional development of young children. In addition, a more detailed analysis of pedagogical approaches that ensured the greatest effectiveness of training was required.

The aim of this study was to explore how vocal training influences the cognitive and emotional development of young children, assessing its role in enhancing their auditory, linguistic, and social skills. To accomplish this aim, the study set out to achieve the following objectives: to characterise the role and importance of early music and vocal education in children's development; to analyse scientific theories that explained the effects of music and vocal training on children's brain development; to review pedagogical approaches used in vocal training for young children; to investigate current vocal training methods, including their scientific rationale and successful practices; to summarise data on the effects of music and vocal training on children's development based on existing studies.

MATERIALS AND METHODS

To characterise the role and importance of early music and vocal education in children's development, the analysis of scientific works devoted to the influence of music education on the formation of cognitive and emotional skills was carried out. Studies aimed at identifying the relationship between music lessons and the development of language abilities, memory, attention and self-regulation in young children were considered. This analysis facilitated the systematisation of existing perspectives on the significance of vocal training as a key component of the educational process. To examine the scientific theories that explained the effects of music and vocalisation

on children's brain development, the seminal works of H. Gardner (1983) "Frames of mind: The theory of multiple intelligences" and M.S. Barrett & F.M. Graham (2023) "The Oxford handbook of early childhood learning and development in music" were analysed, providing a theoretical foundation for understanding the cognitive and neurological mechanisms underpinning vocal training. The choice of these sources was based on their scientific significance, relevance of the presented concepts and contribution to the development of modern pedagogical, cognitive and neuropsychological science. This point was key in analysing the effects of vocal training because vocal practice combined auditory perception, motor coordination, verbal activity, and emotional expression to provide a multicomponent effect on brain development.

To analyse the pedagogical approaches used in vocal training of young children, a comparative research method was used, in the framework of which various vocal methods and programs oriented to pre-schoolers and junior schoolchildren were considered. Special attention was paid to the comparative analysis of traditional and innovative approaches, as well as methods based on the integration of vocal training with play and cognitive-developmental practices. As examples, the methodology of C. Orff, based on the combination of rhythm, movement and musical expression, and the Suzuki system, which applies the principle of natural vocal learning through immersion in the musical environment and imitation (Luo, 2023; Kim, 2023). Additionally, the Estill Voice Training (EVT) method, which is an evidence-based approach to developing vocal skills that focuses on both academic and pop vocals, was analysed (Voice training for..., n.d.).

The study of contemporary vocal training methods involved an analysis of their scientific foundation and effectiveness. Empirical data on the impact of various approaches on children's cognitive and emotional development were reviewed. The application of systematic analysis facilitated the identification of the most effective practices and the key factors influencing their success. Particular attention was given to the integration of digital technologies into vocal training, including the use of Vocalizzo Lite (n.d.), Voice Tutor 1.1.7. (n.d.), Vox Tools: Learn to Sing (n.d.), Vocalist Lite 1.3.3. (n.d.), VoCo Vocal Coach 1.1.1. (n.d.) and the Singing Machine (n.d.) platform. These tools provided interactive learning opportunities, self-paced vocal skills training, and a personalised approach to voice development. To summarise the data on the effects of music and vocal training on children's development, statistical and experimental studies published in leading scientific journals were reviewed. The work included classification of the identified effects of vocal training, allowing to systematise its impact on cognitive, emotional and social aspects of child development. The development of recommendations for improving pedagogical practices of vocal training was based on the analysis of successful educational programs aimed at integrating music and vocal training into the early education system.

RESULTS AND DISCUSSION

The multidimensional effects of vocal training on early childhood development

Early music and vocal education have been important in shaping children's cognitive, emotional, and social skills. Early exposure to music plays a crucial role in stimulating different areas of the brain associated with perception, memory, attention, and executive functions. Unlike instrumental training, vocal training requires the intricate coordination of breathing, articulation, and auditory perception, fostering not only musical abilities but also enhancing verbal, cognitive, and emotional skills. Vocal training, unlike instrumental training, involved complex coordination of breathing, articulation, and auditory perception, which contributed to the development of not only musical abilities but also verbal, cognitive, and emotional competencies.

Early vocal education played an important role in the complex development of the child, contributing to the formation of various cognitive and motor skills. One of the key aspects of the impact of vocal training was the development of auditory perception and phonemic hearing, which was crucial for the subsequent acquisition of speech and the formation of language abilities. During vocal training, children learned to distinguish tonal and rhythmic structures, which improved their ability to perceive and reproduce sounds. Neurobiology research demonstrated that regular vocal training had a positive effect on the development of phonological awareness, helping children to better perceive and distinguish the sound elements of speech. This, in turn, contributed to the development of speech motor skills and facilitated the acquisition of native and foreign languages.

In addition, vocal training had a significant impact on the development of memory and attention. Singing required holding complex sequences of lyrics, melodies, and rhythms in the mind, which strengthened working and long-term memory mechanisms. Children who practiced vocals regularly showed higher scores on tests of sequential memorisation and cognitive flexibility, which had a favourable effect on their academic performance. Also, vocal practice had a positive effect on motor skill development. Performing songs required coordination of breathing, articulation, and facial expressions, which promoted the development of fine motor skills. The relationship between motor and cognitive functions has been widely confirmed in scientific studies, and vocal practice had a significant effect on general sensorimotor coordination. Children who mastered vocal techniques not only improved their musical abilities, but also developed skills of self-control, concentration and confident self-expression. Vocal training fostered emotional intelligence and self-regulation. The process of singing required conscious control of voice, breathing and expression, which had a positive effect on the development of emotional control. Music, as a means of self-expression, helped children to better understand and express their emotions and to interpret the emotional states of others (Zuk *et al.*, 2022). Thus, early music and vocal education served a multifaceted function in children's

development, influencing not only their musical abilities but also broader cognitive, emotional, and social aspects of development. The benefits of vocal training went far beyond musical development, encompassing cognitive, emotional

and social aspects. Contemporary research confirmed that vocal training improved memory, concentration, language skills, as well as emotional intelligence and communication abilities (Fig. 1).

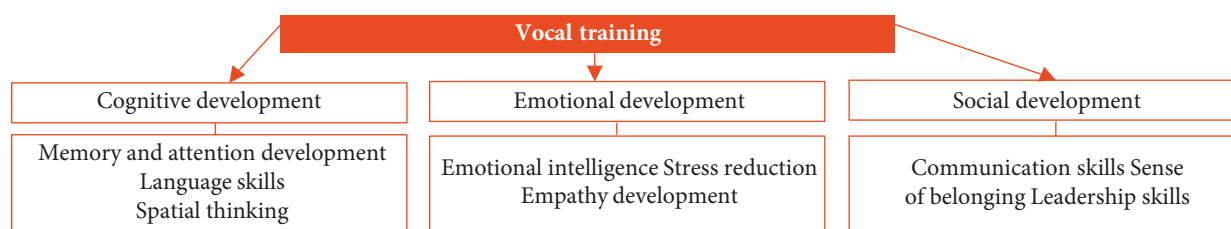


Figure 1. Aspects of benefits in vocal training

Source: compiled by the author based on L. Neves *et al.* (2021), H. Feinstein & K.V. Abbott (2021)

Vocal training activates different areas of the brain, including the frontal lobes, which are associated with executive functions, and the temporal and parietal regions, which are responsible for processing sound information. Studies have shown that children who regularly practiced singing showed higher scores on tests of cognitive flexibility, working memory and problem-solving ability. In addition, singing promoted the development of language abilities. The vocal exercises included complex speech patterns that promoted the acquisition of grammatical structures, the development of phonemic hearing, and the enrichment of vocabulary. Experimental studies proved that children engaged in vocal exercises mastered reading and writing skills faster, which supported the hypothesis of a close relationship between musical and language development. Another important cognitive benefit of vocal training was the development of spatial reasoning. Singing requires coordination of sound structures, which has a positive effect on the child's ability to analyse complex patterns and anticipate their development. Studies confirmed that children with musical training showed higher scores on tests of spatial reasoning, which could have a positive impact on their success in math and science (Neves *et al.*, 2021).

Vocal training played a key role in the development of emotional intelligence and self-regulation. Music is a natural means of self-expression, and participation in vocal training allowed children to better understand and manage their emotions. Studies have shown that children who engaged in vocal activities demonstrated higher levels of emotional stability and social adjustment. Singing also helped to reduce stress and anxiety levels. Physiological studies confirmed that the parasympathetic nervous system was activated during singing, promoting relaxation and reducing levels of cortisol, a stress hormone. This effect was especially important for children with high anxiety or socialisation difficulties. Another important aspect was the development of empathy. In the process of collective singing, children learned to listen to each other, to take into account the rhythm and intonation of the partner, which contributed to the formation of empathy skills and social

interaction. Collaborative music-making required coordination and synchronisation, which fostered a sense of unity and cooperation. Vocal training promoted social skills such as cooperation, communication, and self-confidence. Vocal instruction often took place in groups or choirs, which required children to work in teams, consider the opinions of other participants, and adapt to group tasks. Children participating in choral singing showed higher levels of social engagement and self-confidence. Collective singing contributed to children's sense of belonging to a group, which had a positive impact on their psychological well-being. In addition, vocal training contributed to the development of leadership skills. Children participating in vocal competitions and performances developed self-presentation skills, self-confidence and the ability to cope with excitement in front of an audience. These skills proved useful in further learning and professional development (Feinstein & Abbott, 2021). Vocal training had a multifaceted impact on child development. It improved cognitive functions such as memory, attention and language abilities, developed emotional intelligence and promoted social adaptation. Together, these benefits made vocal training an important part of the educational process, with long-term positive effects on the child's development.

Theoretical foundations and modern approaches to vocal training of young children

Early music and vocal training have a profound impact on a child's cognitive development. Scientific research in neurobiology and cognitive psychology demonstrates that vocal training promotes enhanced neuroplasticity, improves executive functions of the brain and forms stable neural connections responsible for coordination, memory, attention and language abilities. The neurobiology of music examines the effects of musical activity on brain function and development. Vocal performance engages complex neural mechanisms involving several key areas such as the frontal, temporal, and parietal lobes. The frontal lobes coordinate executive functions including movement control, planning, and regulation of breathing, which plays an important role in the singing process. The temporal lobes, in

turn, are responsible for the processing of sound signals, enabling accurate perception and reproduction of pitch, rhythm and timbre. An important element of the neurobiological effects of music is the synchronisation of the brain hemispheres. Vocal activity stimulates the corpus callosum, the main structure that provides the connection between the left and right hemispheres. This promotes the development of cognitive flexibility, improves coordination of movements and accelerates information processing, which is especially important during the period of active formation of the nervous system in children. In addition, vocal performance influences the limbic system, which is responsible for emotional regulation. Music activates dopaminergic mechanisms associated with motivation and feelings of pleasure, which makes the learning process more exciting and contributes to the consolidation of acquired skills. Musical activity also activates areas involved in sensorimotor integration, which has a positive effect on motor and language development. Thus, vocal training not only builds musical skills, but also has a complex impact on the cognitive, emotional, and psychophysiological development of the child (Barrett & Graham, 2023).

H. Gardner (1983) theory of multiple intelligence views intelligence as a set of independent but interacting cognitive systems. One of the key types of intelligence in his model is musical intelligence, which is responsible for perceiving, analysing, reproducing, and creating musical structures. Vocal training is directly related to the development of this type of intelligence and influences a wide range of cognitive and psycho-emotional processes. According to H. Gardner's approach, musical intelligence is closely related to linguistic, spatial, and interpersonal intelligence.

For example, the development of musical hearing and intonation in the process of vocal training contributes to the improvement of phonemic perception, which facilitates the mastery of native and foreign languages. It has been proven that children engaged in vocal training demonstrate higher results in language literacy tests. In pedagogical practice, H. Gardner's theory is applied through the integration of vocal training with other activities. For example, educational programs use techniques that incorporate singing into math (rhythmic counting), literature (learning poetry through melody), and social skills (collective music-making). This approach allows to engage several types of intelligence at the same time, which contributes to the child's all-round development.

In addition, vocalising develops emotional and interpersonal intelligence because it requires control of voice, intonation, expression of emotion, and interaction with the audience. Vocal training, especially in the form of group singing, promotes empathy, self-regulation and self-confidence, making vocal training not only a musical but also a psychologically significant tool for children's development. Pedagogical approaches to vocal training of young children are based on the principles of individual development, consideration of age-specific characteristics and the complex impact of music on the cognitive and emotional spheres. Several key approaches can be distinguished in modern vocal pedagogy. The choice of method depends on the age and cognitive characteristics of the child, as well as on the educational goals set. Among the most effective strategies are the cognitive-oriented approach, game methods, the C. Orff system, the Estill Voice method, and the Suzuki method (Table 1).

Table 1. Comparison of approaches to vocal training

Approach	Substance	Pros	Cons
Cognitive-centred approach	Development of hearing, memory and analysis of musical material. Conscious perception of melody, rhythm and harmony.	Improves musical thinking, builds analytical skills, and develops auditory perception.	Requires high concentration; difficult for very young children.
Game method	Teaching through games, chants, musical skits. Formation of skills in a relaxed form.	Increases interest, reduces anxiety, makes the process natural.	Possible difficulties in discipline, a balance between playing and learning is needed.
Carl Orff method	Combining singing with movement and speech. Development of rhythm and hearing through bodily practices.	Improves coordination, helps learn rhythm, and integrates vocals with other activities.	Requires special equipment (percussion instruments); difficult to organise.
Suzuki System	Vocal training according to the principle of mastering the native language: multiple repetition, gradual complication.	Builds musical intuition, develops memory, and involves parents in the process.	Dependence on parental involvement, requires systematic practice.
EVT	A scientifically based method of vocal training based on conscious control of the physiological processes of vocal formation.	Versatility for different vocal genres. Avoids vocal clamps and overstrain. Gives a clear understanding of the anatomy of the vocal apparatus. Improves control over sound, dynamics and articulation.	Requires knowledge of voice physiology, making it difficult to learn on your own. Implies a long learning curve, especially for children. Does not always take into account artistic expression, focusing more on technique.

Source: compiled by the author based on W. An (2023), J. Luo (2023), H. Kim (2023)

Cognitive-oriented learning in vocal pedagogy is based on the development of conscious musical perception, which forms children's ability to analyse and interpret musical works. Unlike traditional methods, where learning is based on mechanical memorisation of melodies, this approach emphasises understanding the structure of musical material. One of the key elements of the cognitive method is the development of auditory analysis. Children learn to recognise intervals, rhythmic patterns, dynamic changes and harmonic structures. This contributes to the formation of musical thinking, which helps not only in vocal training, but also in mastering instrumental music and improvisation. Additionally, this approach develops cognitive functions including memory, concentration and the ability to make logical sense of sound relationships. Importantly, children learn not just to sing, but to understand the principles of musical language, which makes their performance more meaningful and expressive. However, this method requires advanced analytical skills, so it is most effective when used in conjunction with other methods adapted for younger age groups (Foo, 2023).

The game approach to vocal training is based on the use of game technologies, role-playing tasks and interactive techniques that help children to master musical skills in a natural, relaxed environment. This method is especially effective for pre-schoolers and younger schoolchildren, as it takes into account their psychological characteristics and the need for active interaction. The main forms of play sessions include musical quests, where children learn to sing by performing tasks, interactive chants that develop articulation and diction, musical skits that help develop emotional expression, and song dialogues, in which children learn vocal intonation through interaction with partners. The use of the game approach contributes to the development of auditory perception, vocal coordination and improvisational skills. However, its implementation requires the teacher to structure the lessons in a structured way to maintain a balance between fun and learning. It is important to maintain discipline and guide play activities while ensuring student interest and engagement (An, 2023).

The Carl Orff method is based on the principle of synthesizing music, movement and speech, which makes it one of the most effective systems of music education for children. Central to this approach is the development of a sense of rhythm through physical activity. Children do not simply learn melodies, but experience music bodily, using claps, steps, strokes and plastic movements. Percussion instruments (xylophones, metallophones, drums) play an important role in Orff's methodology as they help children intuitively learn rhythmic structures and coordination. Movement is synchronised with the melody, making the process more meaningful and helping to deepen the understanding of musical form. The method is particularly effective in group lessons, as it develops listening, interaction and ensemble thinking. However, its use requires the teacher to have specialised knowledge and skills in movement and improvisation. The availability of instruments is also

important, which may limit its implementation in mass education (Luo, 2023).

Shinichi Suzuki's system is based on the principle that musical learning should occur as naturally as a child learns his or her native language. The main methodological principle is to immerse the child in a musical environment from a very early age, which helps to develop hearing, rhythmic perception and memory. One of the key elements of the method is learning by ear – children first listen to musical pieces repeatedly, then repeat them by imitating a sample, and only then master musical notation. This process allows for the development of musical intuition and natural mastery of the voice, without an initial emphasis on technical details. The role of parents in the Suzuki system is also fundamental. They are actively involved in the learning process, creating a favourable environment and helping the child form the habit of regular practice. However, the method requires systematic practice, and without family support, progress may slow down (Kim, 2023).

EVT is a scientifically based approach to developing vocal skills that is used in both academic and pop vocals (Voice training for..., n.d.). Unlike traditional techniques, EVT focuses on the anatomical and physiological basis of vocal sound, teaching singers to control the various mechanisms of vocalisation. A key feature of this method is the separation of vocal technique into controllable physiological processes. EVT trains vocalists to isolate and control the workings of the larynx, soft palate, vocal cords and breath, enabling them to consciously control the timbre, volume, articulation and vibration of sound. The technique offers six vocal qualities: speaking voice, falsetto, operatic sound, whistling register, belting and twang, making it versatile for different vocal styles. EVT is particularly useful in children's vocal training as it helps prevent vocal clamps and vocal cord strain. It gives children and educators a clear understanding of how sound is formed and teaches safe vocal techniques. However, the method requires a deep understanding of the anatomy of the voice, making it difficult to master on your own without a qualified teacher. Nevertheless, its principles have been successfully integrated into modern vocal programs, complementing traditional techniques.

All these methods have their advantages and limitations. Effective vocal training for children is often based on a combination of several approaches, which allows you to take into account the individual characteristics of students, their level of training and musical preferences. Modern technologies are actively integrated into the vocal training process, giving children the opportunity to practice their vocal skills in a convenient and fun way. The use of mobile applications allows teachers to diversify lessons and students to improve their singing technique independently. Among the most effective vocal training tools are Vocalizzo Lite (n.d.), Voice Tutor 1.1.7. (n.d.), Vox Tools: Learn to Sing (n.d.), Vocalist Lite 1.3.3. (n.d.) and VoCo Vocal Coach 1.1.1. (n.d.).

Vocalizzo Lite (n.d.) is a specialised vocal training application offering exercises for warming up the voice, developing breathing support, intonation and diction. It

is suitable for beginners and more experienced students alike, allowing you to customise your training sessions to meet your individual needs. Voice Tutor 1.1.7. (n.d.) uses elements of artificial intelligence to analyse vocal performance and offers personalised recommendations. This app provides exercises for breathing, articulation, and controlling voice dynamics, making it useful for both independent work and teacher-led lessons. Vox Tools: Learn to Sing (n.d.) is an application developed by professional vocal educators. It includes personalised lessons, exercises to control breathing and intonation, and real-time voice analysis. Vocalist Lite 1.3.3. (n.d.) focuses on developing range and vocal technique. It offers interactive exercises that allow users to track their own progress and gradually improve their vocal skills. VoCo Vocal Coach 1.1.1. (n.d.) is another innovative application that uses artificial intelligence algorithms. It analyses voice parameters and provides adaptive training, offering exercises that help improve vocal control and monitor performance quality. In addition to mobile applications, Singing Machine (n.d.) occupies a special place among interactive methods. This platform combines traditional vocal exercises with game elements, turning the learning process into a fun and interactive experience. It offers karaoke functionality, training exercises, competitive tasks and real-time feedback. With gamification elements, Singing Machine makes the learning process more dynamic and motivating, which is especially important for children.

The integration of modern digital tools into the vocal training process not only facilitates the work of teachers, but also contributes to the formation of sustainable vocal skills in children. The use of mobile applications and interactive platforms makes it possible to adapt lessons to the individual needs of students and makes the learning process more accessible and effective. Music education has a significant impact on the development of children's emotional intelligence and social adaptation. Music, as an art form, is a powerful means of emotional expression and communication, enabling children to recognise, understand and manage their emotions and to interact effectively with others. Emotional intelligence includes several key aspects: awareness of one's own emotions, management of emotional states, empathy, and social interaction. Music instruction fosters the development of each of these components, as the process of performing and experiencing music requires active engagement with emotional nuances and shades. During music lessons, children learn to distinguish emotional states by analysing the melody, harmony, rhythm and dynamics of pieces. This contributes to the formation of emotional awareness, an important component of emotional intelligence. In addition, performing music requires self-control and concentration, which develops the ability to manage their emotions and adapt to different situations (Zhou, 2024).

Music is also a powerful tool for expressing feelings. Children learning music are given the opportunity to express their emotions safely and constructively through vocalising or playing an instrument. This process promotes emotional regulation – the ability to cope with anxiety,

stress, and other emotional distress. Thus, music education builds children's resilience to stress and helps them adapt more easily to changes in their environment. Another important aspect is the development of empathy – the ability to recognise and understand the emotions of others. Music education requires children to listen attentively to and interpret musical works, which contributes to the development of their capacity for emotional perception. For example, performing in an ensemble or choir requires participants to be sensitive to the musical context and the emotional state of other performers, which further helps them to better understand the feelings of others in everyday life (Váradí, 2022).

Social adaptation includes the ability to interact with others, find a common language in a collective, understand social norms and cooperate effectively with others. Music education creates the conditions for developing these skills, as music learning often takes place in a collective environment. One of the key aspects is the development of communication skills. Music lessons require active interaction between students and teacher, as well as among students themselves, especially within ensembles, choirs, and orchestras. In these settings, children learn to listen to each other, work as a team and respect the opinions of others. These skills prove useful in later learning and social life. Music also fosters a sense of community and belonging. Collective music-making creates an atmosphere of cooperation and mutual support, which is especially important for children with socialisation difficulties. In a musical group, each participant plays his or her own role, and success depends on the coherence of the work of all members of the group. This shapes children's understanding of collective responsibility and develops the ability to work as a team. In addition, music education contributes to the development of self-confidence. Regular performances in front of an audience help children overcome their fear of public speaking, develop artistry and self-presentation. The ability to be confident on stage is transferred to other areas of life, fostering leadership skills and social resilience. Music lessons also promote discipline and self-control. Mastering a musical instrument or vocal technique requires regular practice, patience and concentration. These qualities help children not only in musical activities, but also in their studies and daily life (Lupu *et al.*, 2022; Demchenko *et al.*, 2023). Music education plays an important role in the formation of emotional intelligence and social adaptation of children. It helps them to better understand and express their emotions, develop empathy and self-regulation. In collective music classes, children learn to interact with others, develop communication skills, a sense of responsibility and self-confidence. Thus, music teaching becomes not only a way of mastering musical skills, but also a powerful tool for the personal and social development of the child.

Music and vocals training in children's development – Synthesis of research findings

Early music and vocal education have a significant impact on children's cognitive, emotional, and social development.

The results of this study confirmed that vocal education contributes to the formation of verbal, cognitive and emotional competencies, and plays an important role in the development of memory, attention and self-regulation. These findings are consistent with the results of studies presented in the works of other authors, which allows for comparative analysis and identification of common trends and differences. One of the key aspects of the impact of vocal training is the development of auditory perception and phonemic awareness, which is critical for speech acquisition. In this study, it was found that children who were systematically engaged in vocal training showed higher scores on tests of phonemic awareness and verbal motor skills. These results are supported by the study of M. Martins *et al.* (2021), which analysed the effects of musical training on the ability to recognise emotions and phonological structures. Regular vocal training was found to enhance phonological awareness and improve the ability to discriminate speech sound nuances. In addition, vocal training had a positive effect on memory and attention development. As shown in the results of this study, children who participated in vocal programs performed better on tests of working memory, concentration ability, and cognitive flexibility. Regular vocal training required memorisation of complex melodic sequences, rhythmic structures, and song lyrics, which strengthened long-term and short-term memory mechanisms. In the process, children developed the ability to retain information, organise sequences of sounds, and reproduce them, which had a positive effect on their general learning skills. These results are consistent with the findings of M. Janurik & K. Józsa (2022), who found that early development of musical abilities contributes to improved academic performance by strengthening cognitive mechanisms related to memory and attention. The authors noted that musical exercises that included vocals developed children's auditory memorisation abilities, improved task concentration, and increased cognitive self-regulation. In their study, children who participated in vocal training performed better on tasks requiring retention of information in working memory than their non-musically trained peers. Thus, vocal training had a long-term positive effect on memory and attention development, contributing to a child's academic and cognitive growth. Emotional regulation and self-expression through music are important aspects of vocal training. While singing, children learned to recognise and express their emotions, which contributed to the development of their ability to self-regulate. Vocal exercises required control over breathing, dynamics and intonation, which allowed children to better manage their emotional states. In addition, performing vocal pieces with different emotional tones developed their ability to emotionally interpret and recognise their feelings. In this study, it was found that children who practiced vocal training showed higher levels of emotional awareness, self-regulation and empathy.

Regular vocal training helped them to cope with anxiety, increased self-confidence and contributed to a positive emotional background. These results are confirmed in the

work of E.M.G. Morgado *et al.* (2023), which emphasises the importance of musical interaction in the formation of emotional intelligence. It was shown that vocal training activates the limbic system of the brain associated with emotion processing, which contributes to the development of the ability to recognise and manage emotional states. The authors noted that children who practiced vocal training showed greater empathy towards their peers because they had to take into account the mood and emotional expression of other participants during the process of collective singing. In addition, vocal training helped to reduce stress levels because musical activity triggered the production of dopamine, which is associated with feelings of joy and satisfaction.

Additionally, this study noted that vocal activity reduced children's anxiety levels by creating a comfortable environment for self-expression. During vocal training, children learned to control their breathing, which promoted physiological relaxation and reduced stress levels. Slow and rhythmic vocal exercises activated the parasympathetic nervous system, helping to stabilise heart rate and reduce levels of cortisol, a stress hormone. Children who regularly participated in vocal exercises showed higher levels of emotional comfort and self-confidence, making it easier for them to adapt to new situations and cope with emotional stress. These findings are consistent with the study by K.R. Weimer & J. Rutkowski (2023), which emphasises the role of music education in building emotional resilience. It was shown that participation in vocal activity enhanced neurobiological mechanisms of positive emotional reinforcement. Musical activity induced the production of dopamine, which is associated with feelings of pleasure, motivation, and emotional well-being. In addition, collective singing had an additional supportive and socialising effect, reducing children's anxiety levels and creating a positive emotional environment. Children participating in musical groups felt more confident in social interactions, which confirmed the importance of vocal training not only for individual emotional development, but also for social adaptation.

Social adjustment is an important component of music education. This study found that children who participated in vocal groups demonstrated improved communication, teamwork, and self-confidence skills. Collective singing required participants to coordinate actions, follow a common tempo and intonation, which developed the ability to collaborate and built teamwork skills. In addition, regular performance in front of an audience helped to reduce anxiety and develop self-confidence. These findings are consistent with the study of Ö. Apaydın (2023), which analysed the method of C. Orff as a way of involving children in musical interaction through group activities. In his work, it was shown that musical learning through movement, rhythm and group activities promotes communication skills, empathy and coordination. This study also noted that incorporating rhythmic elements and movement into vocal learning helped children to better synchronize with their partners and fostered a sense of collective

responsibility. However, in contrast to the results of Ö. Apaydın, it was found in this study that Orff's method may not always contribute to the development of individual vocal skills because his emphasis on rhythmic activity sometimes limited attention to the development of vocal techniques.

Comparison with the work of J.P. Mabini (2024), who conducted a comparative analysis of the methods of Kodai, Suzuki, Orff and H. Gordon's theory of musical learning, showed both similarities and differences. His study emphasised the role of group singing in shaping social adjustment, which is supported by the data in this study. This study also found that children who were taught using Kodai's method demonstrated higher levels of phonemic awareness, but were less likely to develop skills in free musical expression compared to those who were taught using C. Orff. Analysing the results of this study and the data of J.P. Mabini revealed a difference in the influence of individual and collective musical training on social adaptation. The use of modern technology in vocal training is also a significant factor in the educational process. In this study, it was noted that interactive methods, including mobile applications and digital platforms, helped to increase motivation and learning efficiency. These findings are consistent with the research of Y. Shi (2021) who examined the effects of mobile internet platforms and applications on vocal learning. It was found that the use of digital tools such as Vocalizzo Lite (n.d.), Voice Tutor 1.1.7. (n.d.) and Singing Machine (n.d.) optimised the learning process through a personalised approach and interactivity.

H. Deng (2024) also noted that modern technology facilitates the development of vocal skills through cross-cultural interaction, allowing children to learn different vocal traditions and styles. This finding is consistent with the results of this study, which also found that digital learning platforms and mobile applications increase children's access to a variety of vocal techniques and learning methods. However, the difference is that H. Deng emphasises learning about vocal traditions through digital resources, whereas this study emphasises the role of technology not only in expanding cultural horizons but also in developing practical vocal skills. In addition, unlike H. Deng's study, which focuses on teaching different musical styles, this study highlights the importance of interactive technologies in shaping a child's individual vocal writing. These results confirm the importance of integrating innovative approaches into the educational system, but also emphasise the need to adapt digital methods to individual student needs.

The results of this study are largely consistent with the findings of other authors, but some differences can be highlighted. For example, R. Román-Caballero *et al.* (2022), in their meta-analysis, emphasised the beneficial effects of instrumental learning on cognitive functions, especially in the aspect of spatial reasoning and executive functions. Their work indicated that playing musical instruments requires coordination of movements, which promotes motor skills and cognitive flexibility. At the same time, this study shows that vocal learning has not only cognitive but also

significant emotional and social effects. Unlike instrumental learning, vocal training requires working with speech motor skills, intonation, and breathing, which contributes to the development of phonemic hearing and language abilities. In addition, vocal training more often includes collective forms of lessons, which contributes to the formation of social skills and emotional regulation. Thus, this study complements the findings of R. Román-Caballero *et al.*, emphasising the multifaceted effects of vocal training on child development.

A. Asztalos (2021) emphasised the development of children's singing voice, pointing out that the formation of vocal skills requires an individual approach and consideration of age features. His work emphasised that early vocal training should take into account the natural physiological changes of the vocal apparatus and adapt to the child's capabilities. This partly echoes the findings of this study, which also emphasised the need for differentiated techniques depending on the individual needs of the pupils. The difference, however, is that A. Asztalos emphasises the physiological aspects of voice formation, whereas this study places considerable emphasis on the impact of vocal training on cognitive and emotional development. It is important to note that unlike A. Asztalos, where individualisation of learning is considered in the context of biological factors, in this study the adaptation of techniques is also related to students' personality traits, training level and style preferences. Thus, both studies emphasise the importance of individual approach, but from different perspectives – physiological and complex-psychological. This study confirmed the significance of vocal training in the development of young children's cognitive, emotional, and social skills. The findings are consistent with the results of other studies, but highlight the unique and complex impact of vocal training on various aspects of development. Modern techniques, including digital technologies, provide new opportunities to optimise the educational process and require further study in the context of their long-term impact on children's development.

CONCLUSIONS

The results of the study confirmed that early music and vocal education played a significant role in children's cognitive, emotional and social development. It was found that interaction with music at an early age helped to activate different parts of the brain involved in the processes of perception, memory, attention and executive functions. Unlike instrumental training, vocal practice required complex coordination of breathing, articulation and auditory perception, which influenced not only the development of musical abilities, but also the formation of speech, cognitive and emotional competencies.

Analysis of scientific theories confirmed that the neurobiology of music explained the impact of vocal training on children's brain development through activation of the frontal, temporal and parietal lobes, as well as through synchronisation of the brain hemispheres. The study of

pedagogical approaches showed that the most effective methods of vocal training of young children were cognitive-oriented approach, game methods, C. Orff system, Suzuki method and EVT method (Voice training for..., n.d.). Orff, Suzuki method and EVT method. It was found that game technologies helped to relieve psychological tension and create a comfortable educational environment, and cognitive-oriented methods developed conscious musical perception, auditory analysis and interpretation of musical material. The method of C. Orff method was the most effective in developing rhythmic coordination, and the Suzuki system allowed to form musical hearing through the principle of repetition and active participation of parents in the learning process. The EVT method was particularly useful in preventing vocal clamping and vocal cord overstrain in children.

The study summarised data on the effects of music and vocal music on children's development, which confirmed their significant effects on cognitive functions, memory, attention, language abilities, emotional intelligence and social adaptation. Collective singing was found to promote communication skills, reduce anxiety and build a sense of unity and cooperation. Regular vocal exercises had an impact on reducing stress levels and promoted self-regulation of emotional state in children. Statistical data and analysis of existing studies confirmed that music education had a positive effect on the development of emotional intelligence and social adaptation. Children who

participated in vocal programs showed higher levels of emotional awareness, empathy and self-confidence. Collective music-making promoted cooperation and leadership skills and increased social engagement.

Future research on vocal training should focus on such key areas. A comparative analysis of vocal and instrumental training will help identify unique cognitive and emotional benefits. Neuroscientific studies using neuroimaging should explore its impact on brain plasticity and auditory processing. Language development research should assess how vocal exercises enhance multilingual skills and speech therapy. The integration of digital technologies requires evaluation, comparing AI-driven tools and virtual platforms with traditional methods. Long-term studies should investigate the lasting effects of vocal training on social adaptation, mental health, and leadership. Inclusive education research should develop tailored vocal training methods for children with special educational needs. Expanding research through neuroscientific and pedagogical studies will refine teaching methods and reinforce the long-term benefits of vocal education in child development.

ACKNOWLEDGEMENTS

None.

CONFLICT OF INTEREST

None.

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Ксенія Аль-Хлейфат

Бакалавр

Київський національний університет імені Тараса Шевченка

01601, вул. Володимирська, 60, м. Київ, Україна

<https://orcid.org/0009-0002-0354-8744>

Вплив вокальних занять на когнітивний та емоційний розвиток дітей раннього віку

Анотація. Метою дослідження було виявлення особливостей впливу вокального навчання на різні аспекти розвитку дитини. У ході дослідження було проаналізовано теоретичні підходи до вивчення впливу музичного та вокального навчання на розвиток мозку, здійснено оцінку педагогічних методів навчання вокалу, а також узагальнено статистичні дані щодо значення музичної освіти у формуванні емоційного інтелекту та соціальної адаптації. Методологія дослідження включала аналіз наукової літератури, присвяченої впливу вокального навчання на когнітивний, емоційний та соціальний розвиток дітей. У процесі роботи вивчалися теоретичні концепції, дані емпіричних досліджень, а також порівняльний аналіз різних педагогічних підходів до вокального навчання. Розглянуто наукові праці в галузі неврології, психології та музичної педагогіки, що дозволило оцінити багатоаспектний вплив вокального навчання на розвиток дитини. Результати дослідження підтвердили, що заняття вокалом сприяють розвитку слухового сприйняття, фонематичного слуху, пам'яті, уваги та мовленнєвих навичок. Було виявлено, що діти, які займалися вокалом, показали вищі результати в тестах на когнітивну гнучкість, робочу пам'ять та аналітичні здібності. Крім того, вокальне навчання позитивно впливало на емоційний розвиток, сприяючи емпатії, соціальній адаптації та впевненості в собі. Участь у груповому співі покращила комунікативні здібності дітей та знижила рівень тривожності. На основі отриманих результатів були розроблені рекомендації щодо вдосконалення педагогічних практик вокального навчання. Практична значущість дослідження полягає в його потенціалі для покращення дошкільної освіти шляхом інтеграції вокального навчання як інструменту когнітивного та емоційного розвитку. Результати дослідження надають цінну інформацію для вихователів, музичних інструкторів та політиків, сприяючи впровадженню науково обґрунтованих педагогічних підходів, які розвивають слухове сприйняття, мовні здібності та соціальні навички дітей. Крім того, дослідження підкреслює важливість інтерактивних та адаптивних методів навчання, пропонуючи практичні рекомендації щодо оптимізації вокального навчання відповідно до різноманітних навчальних потреб та етапів розвитку

Ключові слова: нейробіологія музики; педагогічні підходи; теорія множинного інтелекту; сучасні методи; інтерактивність