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Psychophysiological factors of effective development of piano technique of future music teachers

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Abstract. The results of successful training of students of music and pedagogy at piano lessons depend on their technical level, and possession of an entire range of skills for the implementation of performance tasks. However, effective development is hindered by psychophysiological factors, namely excessive hand clenching, the inability to rationally use the necessary muscle groups and to distribute the load on the body in a balanced manner. The purpose of the study is to analyse the process of development of performance skills through the understanding of psychophysiological characteristics. The methodological basis was established by the works of Ukrainian and foreign scholars, pianists and teachers. A set of methods was used to solve the tasks: analysis, systematisation, classification, and generalisation of pedagogical experience. Descriptive and didactic methods were used to outline technical performance problems and ways to solve them; the method of pedagogical observation was used to test and confirm the effectiveness of the chosen methodology. The research emphasises the key points of correction of body posture, which help to eliminate excessive stiffness of movements, and overstrain of weaker muscle groups and have a positive impact on the development of performing freedom. First and foremost, it's about sitting properly at the tool, developing a sense of the weight of the hand at rest and during lifting. The research offers tested exercises that ensure the fixation of optimal muscle sensations in the shoulder girdle area, especially in the area of the scapula and shoulder joint, during various arm movements. Another common problem is insufficient attention to the functioning of the finger extensor muscles, which impedes the development of their dexterity and independence and causes wrist stiffness. The significance of educating students to consciously master primary motor skills based on specific muscle sensations is substantiated. The results of the study prove that a certain algorithm of actions in the setting of the game apparatus and the correction of deficiencies can ensure the stability of performing freedom, self-control and self-regulation of motor actions

Keywords: music pedagogy; formation of technical skills; organisation of playing movements; tension and relaxation of muscles; sitting at the instrument; self-control of motor actions

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INTRODUCTION

Modern perspectives on the problem of developing technical skills have emerged as a result of a rethinking of the historical process of piano pedagogy and performance. Nowadays, the question of the relationship between a pianist's technique and psychophysiological characteristics is

becoming increasingly important at different stages of music performance training: from the initial period to the acquisition of professional skills. The development of piano technique involves the coordination of mental processes with appropriate physical movements. All the mental processes



of a pianist's performing actions are manifested in the work of the muscles, in changes in muscle tone. In the 19th century, the connection of muscle movements with the human psyche, namely, the unity of the cognitive process and motor functions, began to be referred to in physiology as "psychomotor skills". In modern science, psychomotor skills are frequently interpreted as "motor activity", "motor activity", "movement physiology", etc. However, it is not just about physical movements but a complex system that encompasses physiological and mental properties. From this, it can be concluded that the pianist's psychomotor skills are a set of actions caused by psychophysiological factors that determine the effectiveness of the development of piano technique.

The development of a pianist's technique is a long and energy-consuming process that begins with mastering basic performance movements and, in fact, never ends, as achieving even a seemingly absolute level of technical skill has no limits to perfection. The quality of pianistic skills, speed and mastery in mastering them depend on how professionally competent and responsible the approach to the organisation of playing movements was at the initial stage of mastering the skills of playing the instrument, which would consider the anatomical and physiological features of the musculoskeletal and muscular system of the body. Insufficient awareness of this frequently leads to disastrous consequences: it causes technical difficulties for beginners, making them reluctant to continue their studies, and for professional performers, it can lead to various hand diseases (epicondylitis, bursitis, tendonitis, etc.). In addition, it is impossible to develop its organic connection with the emotional and auditory spheres without adjusting the motor sphere.

Currently, in higher music and pedagogical education, there is a situation where students with different levels of pre-university training in piano skills are enrolled: graduates of primary music schools, professional colleges, and those who have learned to play the piano on their own. The development of future music teachers' professional competences requires them to possess knowledge and skills that they can pass on to their students. Thus, it is crucial for them to realise the relationship between the effective results of piano training and the psychophysiological characteristics of the performance process, to learn self-control and self-regulation.

A prerequisite for the development of performing skills of piano students with a low level of pre-university training, as noted by A. Grinchenko (2022), is to consider physiological and psychological characteristics. The author considers auditory-motor coordination to be one of the pianist's synthesised skills, which is designed to subordinate motor actions to auditory representations. In her opinion, "lack of or insufficient coordination is manifested in 'clumsiness' and unnecessary movements when playing. It is a skill that can only be developed by exercising self-control...". This opinion is confirmed by L. Guseynova (2020), who believes that "technical obstacles should be overcome through the active participation of consciousness" and that this process consists of the ability to analyse the causes of technical

failures and choose the right methods to eliminate them. But in both studies, insufficient attention is paid to the root causes of performance shortcomings – flaws in the staging of piano movements, which provoke the existing problems and require appropriate methods of correction.

A fundamentally different approach is demonstrated in the research project of R. Niu (2020), in which he examines the causes of physiological injuries based on research data on the specifics of piano pedagogy and performance in China. The author considers the correct position of the instrument and the development of important and useful habits for playing the piano as the main condition for preventing injuries and chronic diseases of the musculoskeletal system. The results of his research aroused a deeper interest in this subject and served as a factor in my analytical judgements, which are presented below.

The purpose of the proposed study is to consider a proven approach, which consists of the rational, appropriate use of muscles and helps piano students to effectively develop their performance skills, and to protect them from undesirable injuries.

LITERATURE REVIEW

The perfect psychomotor self-regulation at all levels of its organisation: mental, sensory and motor – as an obligatory component of music performance activity was emphasised by K. Martinsen (1966). At the beginning of the 20th century, a prominent psychophysiological, founder of the scientific theory of psychophysiological organisation and regulation of movements N. Bernshtein (1967) considered the problem of coordination of various components forming a complex structure of human motor actions to be one of the main ones in music pedagogy, noting that most technical defects that occur during piano playing are the result of inconsistencies in the work of the main links of the student's psychophysiological apparatus. M. Bernstein's research was continued by the theory of V. Sradzhev (1987) on the coordination of movements at different levels of psychomotor activity, which became an important stage in the improvement of piano technical skills.

An analysis of contemporary works by Ukrainian scholars in the field of piano performance and music pedagogy demonstrates that the problem of the influence of psychophysiological factors on pianistic qualities and the development of performance skills is the least explored. Evidently, it is caused by the fact that, as is known from the history of piano pedagogy, there was no single scientific and methodological approach to the problem of technical development. Each of the schools of piano technique development – mechanical, anatomical and physiological, and psychotechnical – denied the basic assumptions of each other, promoting their ideas. Currently, scientific studies are appearing whose authors, based on these different, sometimes opposing, ideas, are trying to define universal key principles for the effective development of a pianist's technique and the existence of its components and analyse the internal relationships in this complex. The issue of pi-

ano technique – as a subject of scientific and methodological works of the leading piano teachers of Ukraine of the 20th century V. Shapiro and G. Beklemishev – is considered by N. Zymohlyad (2015). In particular, the author notes that analysing the work of the adherent of the anatomical and physiological school of P. Ramul, the prominent teacher, representative of the Kyiv piano school G. Beklemishev critically evaluated the author's attempts to subordinate performance movements to the laws of physiology and even considered them harmful to pianists, since, in his opinion, "constant attention to the active or passive state of the hand can cause psychological stiffness", while supporting the idea of analysing movements that the performer should "...fix, memorise them through repeated repetitions" (Zymohlyad, 2015).

Ye. Cherniak and S. Zankova (2017) highlight the theoretical and practical aspects of the development of future instrumentalists' performance techniques and classify historically established methods of working on its development (mechanistic, intuitive motor, conscious motor, conscious auditory), noting that all these methods in a single and interdependent process represent a psychophysiological approach, where there is a synthesis of consciousness and movements.

The problem of the ontogeny of performing skill in terms of functional detection of the process of automation of playing movements and motor memory of future music teachers is considered by V. Husak (2013). Based on a retrospective analysis of the scientific heritage, the author explores the psychological features of skilful playing, the role of mental processes in the development of performing skills, patterns, methods and techniques of its development in the process of instrumental training of students.

The psychophysiological features of the organism, which provide the necessary speed of motor reactions during playing, explain the innate ability of a performing musician to play skilfully G. Tsypin (1984): "Students are more or less naturally gifted in motor-technical terms, just as they are more or less capable in terms of musical hearing and rhythm. However, innate properties are only part of the story. The other, no less important, is related to learning," thus confirming the importance of considering psychophysiological factors in piano training.

The significance of technical development as a performing component in the education of the professional culture of a music teacher is emphasised by V. Irkliienko and N. Demyanko (2019). Therewith, Bing Wang's (2010) research proves that the analysis of scientific and methodological literature and practical experience has demonstrated the existence of several contradictions, in particular "between the bifunctionality of the future music teacher's performance technique and the unidirectionality of its development in the learning process". It confirms the author's opinion that the fundamental principles of performing the technique, which is based on the correct body position and organisation of piano movements, still receive little attention. Therewith, the development of piano technique is one of the priority tasks in the training of future music teachers.

Contemporary foreign scholars are much more active in demonstrating interest in the issue. Psychophysiological nature of piano movements and their coordination is emphasised by M. McLachlan (2014; 2017), J.I. Pozo (2022). In particular, highlighting the problem of the importance of psychological processes in music education, J. Pozo gives a positive assessment of the methodological principles that consist in the education of self-control and self-regulation of the student's performance actions. Such an approach focuses on the relationship between the student's movements and the instrument, namely how their movements can transform the sound produced by the instrument. The author emphasises that "...instead of giving instructions or closed explanations, the teacher encourages the student to make decisions, try to understand why things are happening and evaluate their actions". Among the innovative piano teaching methods analysed in the publication by Z. Ye Yang (2020), mentions the possibility of correcting performance movements using appropriate computer programmes. However, the author considers the principle of their work to be imperfect and emphasises the superiority of conventional methods of developing piano playing skills.

Research on the interdependence of pianistic qualities and psychophysiological factors has gone beyond the boundaries of music-pedagogical and artistic sciences and has become interdisciplinary. For example, the nature of neuroplasticity in somatosensory-motor integration functions through intensive piano training is considered by M. Hirano *et al.* (2020) together with other Japanese neuropsychologists.

Differences in the proprioceptive and motor functions of children who play the piano and those who have never played the instrument were analysed by Y.-T. Tseng *et al.* (2020) from Taiwan, proved the effectiveness of piano lessons in terms of their benefits to children's fine motor skills, provided the wrist is in the correct position.

The reaction of the back and forearm muscles when different pianists perform the same fragments of classical music was explored by a group of scientists from the Polytechnic University of Turin, Italy, in the laboratory of neuromuscular system engineering. The study they conducted using electrodynamic devices confirmed the initial hypothesis that improper functioning of the forearm flexor and extensor muscles potentially increases the risk of injury in professional pianists (A. Thio-Pera *et al.*, 2022).

A thorough study of the specific features of the piano technique in terms of the efficiency and economy of muscle use, according to their motor potential, for coordinated and smooth performing actions was conducted by B. James (2018). The scientist emphasises that "music performance is a complex sensorimotor behaviour that becomes automated through involvement of all motor and sensory areas of the brain through systematic practice with auditory feedback". The research analyses the organisation of the movement of various components that affect the technique of the game from the standpoint of biomechanics; the effect of gravitational force, which ensures the balance of the

torso in a sitting position and the regulation of performing movements, is considered.

The irrational use of muscles and excessive joint loading as causes of occupational diseases of the musculoskeletal system of pianists are analysed in the dissertations of L.F. Rayo (2020) and B.A. Lister-Sink (2015).

The analysis of the above sources demonstrates that piano technique is a constant process of improving movements, and the success of its development depends on the level of control over them, which consists both in making these movements automatic and in improving the quality of this automaticity, which cannot be achieved without considering the psychophysiological nature of performance actions.

MATERIALS AND METHODS

The study is based on the author's many years of experience in teaching piano to students of various categories: from beginners to students who are actively engaged in performing activities. For the past ten years, the author has been teaching students of the Faculty of Music and Pedagogy at a classical university who master performance skills, mastering the instrument at various levels (from beginner to advanced). The author's pedagogical observations over a long period allowed identifying common problems of students' technical development, identifying and characterising the most common causes of shortcomings. The methodology of developing the performance skills of future music teachers, which has been developed over the years, has allowed the development of the results presented in the research.

The methodological and theoretical foundation of the research is based on the works of prominent leading scholars in musicology, theory and methods of music and pedagogical education, piano teaching methods, psychophysiology, neuropsychology, and biomechanics. The criteria for selecting the literature are conditioned by the necessity to cover the outlined problem comprehensively, based on the basic pedagogical principles of piano technique development (Martinsen, 1966; Gat, 1968; Tsypin, 1984; Sradzhev, 1987), and involving knowledge about the psychophysiological aspects of performing movements (Bernshtein, 1967; Mazel, 2001; Mark, 2003; Hall, 2004; Kokun, 2006; McLachlan, 2014, 2017, etc.), biomechanical regularities, which are crucial for the effectiveness of the training process, but are frequently ignored in solving technical problems in practice. To achieve this purpose, a set of theoretical and empirical methods was used. Using the methods of analysis, systematisation and comparison of the data obtained, generalisation of pedagogical experience, the current state of the problem in psychological and pedagogical, music and pedagogical and methodological literature is determined, and current trends in the piano training of students of music and pedagogical profile in Ukraine are considered. The application of these methods confirmed the need to revise the approach to the development of piano technique, which is based on conventional, outdated methodological principles and focuses on achieving the desired result through intensive, rather harmful, training. In

addition, the above methods allowed identifying alternative criteria for the development of performance skills (Lister-Sink, 2015; James, 2018; Niu, 2020; Rayo, 2020) based on the properties of psychophysiology and the laws of biomechanics and substantiating the methodological principles of their improvement. Using the classification method allowed identifying the reasons that hinder technical development and threaten the physical health of students: incorrect posture while sitting at the instrument, which adversely affects the muscles of the neck and lumbar spine and can cause spinal deformities; irrational methods of organising primary movements at the piano, which develop bad habits; inability to achieve complete relaxation, which causes stiffness of movement and overload of the joints; insufficient elasticity and mobility of the fingers due to improper functioning of the flexor-extensor muscles. The results of the study are based on the descriptive method: the cause-and-effect relationship of the above problems is considered, which consists in a violation of muscle balance and overload of joints, and therefore – clamping of the wrist and forearm, inability to achieve freedom and ease in performing technical tasks. Using the didactic method allowed for highlighting the “preventive” pedagogical approach, which demonstrates such methods of organising game movements that prevent the occurrence of the listed problems and ways to correct the existing shortcomings. The effectiveness of the proposed approach has been tested and confirmed using the method of pedagogical observation.

RESULTS AND DISCUSSION

According to the author's observations, majority of the students have forearm tension, stiffness of movements, and rapid fatigue of the muscles of the hands, which adversely affects the educational and creative process and the performance of artistic assignments. It is quite difficult to correct these shortcomings, especially for advanced students, when the established piano movements have become habits developed over the years and are caused by individual psychophysiological characteristics: temperament, behavioural style, physical structure of the body, some of which have psychosomatic manifestations.

Everyone who learns to play the piano, and any other musical instrument, perceives the hands as the main mechanism of the performance process and understands that the effective use of creative possibilities depends on their dexterity. Therewith, as noted by V. Mazel (2001), it should be remembered that “the hand is a part of the body, and its motor and power actions should be fully subordinated to the physiological laws of the human body”. Thus, when it comes to the basics of learning to play the piano, the question remains: what is more important and correct to “set” – the hands or the body. The author's opinion on the answer to this question is outlined below.

Experience demonstrates that many teachers pay great attention to hand posture without giving due importance to the entire body. In other words, the hands (“forearms”, “hands”, “fingers”) are used as the main instrument for

producing sound on the instrument in complete isolation from the stronger muscles of the body. By the time a student starts playing an instrument for the first time, it is not important whether they are a six-year-old child or a seventeen-year-old student, they have already developed a set of movements that they use in everyday life, such as sitting, waving their arms, raising and lowering them, etc. The problem is that when starting to learn to play the piano, it will be necessary to change your habits and cultivate the movements that will be needed to design and successfully develop your piano skills. Thus, the purpose of the initial lessons should be to thoroughly prepare the student's body for completely new motor sensations. Admittedly, the sooner this process occurs, the younger the performer, the faster it can be done, and the easier it is to learn new movements. The problem is complicated by the fact that a prerequisite for such a change is the cultivation of these habits in everyday life. The new sensations should be stable in all actions of the student, as using new movements only on the instrument will not give the desired results. According to O. Kokun (2006), a Doctor of Psychology, Professor, and author of a textbook on psychophysiology, "learning new motor skills, a person ('human being') develops new spatial models of the body, which constitute the foundation of a dynamic image". It is a long process that requires patience and perseverance, and exercises that will develop muscle connections that will correspond to new forms of movement will be useful.

Textbooks on psychophysiology define the following classification of muscle groups: very strong – legs, hips; strong – shoulder girdle area; relatively strong – forearm muscles; relatively weak – neck, hand; weak – fingers (O. Motuziuk *et al.*, 2017). Logically, the main load should be borne by the strong leg and back muscles – as a force generator. As for the back, its importance in the work of musicians, especially pianists, is crucial. The spine is the part of the nervous system that is in contact with all organs and systems. It sends signals if there is irrational use of muscles, their overstrain. Uncomfortable feelings or pain symptoms should not be ignored since, according to the world-renowned spine specialist, professor at the Canadian Spine Institute H. Hall (2004), "pain does not require treatment, it requires control. And understanding, awareness of this is the first step in solving the problem". In his opinion, back pain is not caused by external factors but by irrational actions of the person, namely: poor posture, uncomfortable working posture, overload in the muscular sphere, etc. For musicians, these factors are caused by poor body posture and improper hand movements while playing the instrument. According to Hall, poor posture and certain types of movements can cause muscle pain and spasms. These considerations are supported by T. Mark (2003), who believes that musicians' pain is the result of inefficient muscle use and harmful movements during performance.

First of all, the problem of slouching at the instrument cannot be ignored. The straighter the student's back is, the less stress is placed on the intervertebral discs, and therefore there is no discomfort in the back. The neck is particularly

important, as the areas of the cervical vertebrae are very delicate and the neck muscles are not strong enough to cope with the stress they have to bear when they are in the wrong position. The point is that when the head is strongly tilted forward, the cervical muscles overextend, unable to withstand the load exerted on them by the head. Nowadays, the problem of overstrain of the neck muscles is extremely relevant. Using smartphones and other gadgets leads to posture distortion and stooping: a posture with the head bent down at a strong angle is a typical phenomenon. It is especially dangerous for children and adolescents whose spine is still developing. As a result of this deformity, in addition to excessive tension of the neck muscles, blood circulation is disturbed, and nerve endings are pinched, which provokes the development of vegetative-vascular dystonia with severe headaches and dizziness. For beginner pianists, the habit of keeping their heads tilted extends to their seating position at the instrument, which adversely affects the development of performance skills. Foci of overstrain in the neck area are dangerous as they spread to other muscle groups, causing tightness in the muscles of the arms and back. Therefore, when sitting at the piano, it is necessary to ensure that the head, neck and back form a single line and perform synchronised movements, and if the performer needs to lean towards the keyboard, it should be done with the entire body, and not by bending the neck and head in isolation.

Another cause of back discomfort that Professor H. Hall (2004), is problems in the lumbar spine. Muscle balance in the waist area both helps to maintain good posture and redistributes stresses that could cause back strain, shifting it to the leg muscles. Notably, this allows both to relieve the back, especially the shoulder girdle, and helps to organise arm movements that require freedom and flexibility. To check whether the load is being redistributed correctly, the professor suggests the following exercise: sit down, straighten your back, and rest your thumbs on the bones of your pelvic joints. To ensure that the back position is correct, without discomfort in the lumbar region, and that the body is supported by the legs, the fingers should feel these protruding bones. If they "hide" in such a way that the fingers cannot rest on them, it means that the spine is curved and, accordingly, the load is transferred to the lower back instead of the legs. Posture development is a psychophysiological action that fosters fundamentally new sensations that should be remembered and recorded in a way that makes them familiar and every day.

When working with students, it is important to pay attention to how they sit at the instrument. Very frequently, it is necessary to correct the bad habit of hunching over while playing the piano, and crossing your legs under the chair (especially when the pedal is not used). Such a position causes unpleasant sensations since the entire load is placed on the lower back, adversely affects the sound quality and causes performance shortcomings. Therefore, the first thing to do is to focus the student's attention on the legs. The recommendations of the teacher of the Royal Northern College of Music in Manchester (England), concert pianist

M. McLachlan (2014) are reasonable and confirmed in the author's teaching activity. From the very first lessons, the teacher advises to develop the habit of sitting correctly on the instrument: for the body to have a single support, to transfer its weight to the legs, namely, to the heels of the feet. To do this, you need to sit on the edge of a chair and keep your feet not parallel but with your heels together (in the form of the English letter V). It is in this position that the weight of the body is transferred to the strongest muscle groups – legs and hips, while the body and arms have maximum freedom of movement. The development of a new posture of the student's body should be based on sensations that help to bring the upper body into a state of balanced equilibrium. It allows for correct posture and easy correction if necessary. After all, when working on the organisation of a student's playing movements, the teacher should always remember the dual nature of the movement process. It is necessary to achieve such a result when the student moves from a state of rest (stationary state) to motor actions with the minimum required expenditure of physical strength. And this is only possible when the upper part of the case is in a state of balanced equilibrium. It is a situation caused by the laws of biomechanics, as argued by B. James (2018): "The entire body is involved in the making of music, providing the playing actions and a stable base for unrestricted upper body movements. When the pelvis is fixed on the piano bench, the gravitational force transmitted from the lower back and pelvis to the legs provide stability for dynamic movements of the torso and arms – where the torso sways from front to back or side to side, and the arms are free to move in front, across and to the sides of the body. When the torso is tilted towards the keyboard, the shoulder complex is well positioned to apply force to the fingers to maintain a stable position on the keyboard."

The specificity of the musician's profession is that one has to constantly perform many different movements that are complex in sensation and form. In this regard, it is important to control particularly vulnerable joints, preventing them from excessively active independent movements. The cervical spine has already been mentioned, and improper flexion and extension of the joints of the hand and elbow are no less dangerous.

The shoulder joints are the most mobile and enduring, supported on all sides by strong muscle groups (O. Motużiuk *et al.*, 2017). The advantage of the shoulder joints is that they have a naturally large range of motion and can therefore perform more load than weaker joints (elbow and hand). In addition, active movements in the shoulder joint area should be primary in the organisation of game movements involving other parts of the arm, as they organise and control the swing movement.

An effective solution to the problem of clenched hands and jerky movements caused by the irrational use of muscle groups was a set of exercises used by the author of the study in individual classes with students. These simple exercises help to balance the load on the arms and spine and have a positive effect on the development of performance skills.

To do this, in a sitting position, it is necessary to simultaneously raise both arms to shoulder-width apart and move them back, fixing this position (Fig. 1):



Figure 1

Be sure to remember the feeling of how the shoulder muscles work (strong muscles hold the weaker ones), and then bring your arms forward with a sharp movement (Fig. 2):



Figure 2

Therewith, a sense of freedom should be maintained. This exercise should be used with beginners instead of the conventional methods still used by many teachers: when a child, sitting at an instrument, raises their arms and brings them forward, putting them on the lid of the piano or keyboard. The argument that this approach is harmful to the organisation of performing movements is that it causes overstrain of the muscles of the entire shoulder girdle and blocks the power impulses going towards the playing part of the arm. As a result, the muscle groups of the scapula and clavicle are idle and the impulses, not finding a way out, are guided oppositely, provoking overstrain in the spine. The vertebrae are compressed and inevitably deformed, which leads to disastrous consequences. In other words, uncompensated loads of muscle groups cause a constant source of tension in the entire shoulder girdle, which accompanies the student in everyday life. In addition, when the student lifts the arm and does not pull it back, as suggested above, but lifts it and brings it forward, the student does not have the opportunity to feel the work of the scapula and clavicle muscles. As a result, the arm begins to function outside the sensation of the scapula as the beginning of the power zone and in isolation from the shoulder and back. And the forearm takes on an uncharacteristic main force load. Thus, it proves once again that the technique of moving the arm to the side and back when lifting is the most physiologically correct. In this case, the student develops the skills of feeling the hand as an integral system with the minimum required degree of tension. In addition, according

to M. McLachlan (2017), it is more natural to move in a circular or arcuate manner, rather than in a straight line, when the muscle groups connecting the joints are strained with minimal force. Once again, it is necessary to emphasise that in the development of the arm swing, students should concentrate their attention on the source of force in the shoulder blade area and fix in their memory those positions in which the feeling of the entire arm and its performing freedom is manifested to the maximum. Whereas the teacher's instruction to relax the shoulders is incorrect, as focusing only on this area does not bring the desired result.

The authors of this study dwell on this issue in such detail as the wrong approach to the organisation of playing movements, which many teachers 'sin' with, is the root from which all subsequent performance problems grow. The Hungarian pianist and teacher J. Gat (1968) emphasised that "...the fact that a beginner sometimes achieves a good musical effect with the help of incorrect movements should not lead the teacher astray. Only those technical solutions are satisfactory that will be effective, that are part of the prospect of musical and technical development of students." Overexertion does not occur on its own but is the result of improper movements. If the muscle groups move the joints on the right way, there is minimal tension. If these movements are unnatural from the standpoint of physiology, muscle groups are overstretched. In this case, even using various additional exercises to release the arms and body will not help and will not give the desired stable result.

Another problem that deserves attention is the development of the ability to relax the hands, as it is quite difficult to achieve a feeling of complete release and relaxation. The entire musical performance technique is based on the cyclical nature of moments of tension and relaxation. An insufficient degree of relaxation is the root cause of stiffness, as uncompensated tensions provoke both localised overstrain of individual muscle groups and stiffness of the entire playing apparatus. For the release process to occur automatically, it is first necessary to distinguish between the concepts of "volitional, active throw" and "free fall". The differences between these two concepts are based on the muscle sensations when the arm is raised and lowered, and they are developed at different stages of training. It is especially important to develop an active throw, which should be done consciously, with this action brought to automaticity – a free fall of the arm. The main problem is that the overstrain of the shoulder girdle muscles at the moment of arm lifting does not allow for full relaxation during the fall, as at this moment the arm is inhibited involuntarily, which provokes the so-called alert reactivity (Mazel, 2001): the student is afraid of the throw and clamps the arm even more. Therefore, to begin with, it is important to develop a sense of suspension of the arm, which is the catalyst for all power-motor actions. It is developed based on two factors: the minimum necessary tension of the shoulder girdle muscles, which help to hold the arm; and a stable feeling of the weight of the arm in the raised state – its working position. A simple exercise by V. Guterman (1984), which

is recommended for use in the classroom: in a standing position, straighten your back, raise your arms until your fingers are at eye level, and imitate movements as if you were threading a needle. What happens at this point: the muscle groups in the back are moderately tense – just enough to keep the arms in suspension, the forearm muscles are relaxed to allow for manipulation of the fingers, while the fingers, especially the tips, are concentrated as much as possible to perform the desired action. In addition, this exercise is useful as it helps to develop a sense of the playing apparatus as an integral system, namely, the relationship between the power and playing areas of the arm.

The specifics of the physiology are that the muscle groups of the arm that move this or that part of the arm are located one joint above the joint they set in motion: that is, the fingers and wrist are controlled by the forearm muscles, the shoulder part of the arm is actuated by the muscles of the scapula, etc. Power impulses come from the top down – this must be remembered to avoid mistakes in the organisation of game movements. A correctly "programmed" pulse should return from the fingers to the shoulder blade. Isolated movements of any of the joints outside of contact with other parts of the arm lead to overstrain of the muscle groups surrounding that joint. As a result, any impulses are blocked in the area of the isolated joint and the entire arm goes through a phase of overstrain. The following exercises are useful for developing a sense of interaction between all parts of the hand as a single system:

1) "pendulum" – in a standing position, first move the arm back, then bring it forward. Perform the exercise holding the shoulder of the "working" arm with the other hand (Fig. 3-4). The student should feel the impulse pass from the scapula muscles to the chest muscles, redistributing muscle tension:



Figure 3



Figure 4

2) arms are lowered along the body and pressed against it. The exercise is performed simultaneously with both hands: first, raise your forearms without taking the elbows off the body, touching the shoulders with the fingers (Fig. 5), then raise your elbows and spread them apart (Fig. 6), then bend the elbows and bring the forearms forward at a 90° angle (Fig. 7), then turn them backwards with the palms of your hands and pull them back until the shoulder blades are closed (Fig. 8). Try to remember the feeling of these movements.



Figure 5



Figure 6



Figure 7



Figure 8

And the last aspect, which, in the author's opinion, is not given enough attention in the methodological literature and pedagogical practice, concerns the correct functioning of the finger muscles, namely the flexors and extensors. It is of fundamental importance, as the flexor muscles are strong, while the extensor muscles are much weaker and require special attention. The flexor muscles are naturally well developed, as the grasping reflex is inherent in a child

from birth (a baby clenches his fists, grabs a toy) and its essence is that when the first (thumb) finger comes closer to the others, something like a pincer is established. Accordingly, as the child grows and develops, the flexor muscles are further developed, while the extensor muscles are hardly used in everyday life. It is not the case with playing the piano, therefore, it is necessary to develop the right habits from the very beginning, which will determine the quality of sound production and technical skill in the future. In addition, it is necessary to prepare the student's hand for new, non-standard sensations necessary for soft contact of the fingers with the keyboard (especially the 1st finger), development of their flexibility and independence.

Very often, insufficient elasticity and mobility of the fingers is caused by the wrong habit of clenching them in a fist. The right and wrong habits for pianists are mentioned in his monograph V. Mazel (2001). In everyday life, the conventional order of fingers clenched in a fist is usually the following: all fingers are pressed firmly against the palm of the hand with the thumb pressing on the index finger (Fig. 9).



Figure 9

Therewith, there is little interaction between the muscle groups of the 1st and other fingers. Fingers clenched in this way cause excessive tension in the hand-forearm area and provoke rapid fatigue of the entire arm. The lack of contact between the 1st finger and the other fingers prevents the required automatic release. And when the student first sits down at the instrument, they place their fingers on the keyboard in such a way that the 1st finger is in contact with the index finger only, "working" in isolation from the rest of the fingers, whose extensor muscles are not involved. It is much more useful to develop the habit of clenching your fist with the 1st finger lying along the palm of your hand towards the little finger (Fig. 10):



Figure 10

It will allow bringing the muscle groups of the thumb and the base of the other fingers closer together and coordinate their actions accordingly. This arrangement of the

1st finger serves as a shock absorber that prevents other fingers from coming into contact with the keyboard and balances the work of the flexor and extensor muscles. In addition, the convergence of the abductor muscles of the 1st and 5th fingers helps to coordinate their actions. When the fist is opened, there is no tension between the outer fingers, which helps to maintain the elasticity of all fingers and avoid wrist stiffness. With this arrangement of fingers, the possibility of natural stretching of the palm increases, especially between the outer fingers.

In addition, it should be added that developing a good habit is about more than just making a fist, it's about holding a pen or pencil. For example, in Ukraine, schoolchildren mostly hold a pen with the 1st and 3rd fingers, while in American schools, children hold it with the 1st finger, which is covered by the other fingers. The difference in the effect of these two habits is similar to the one described above – in the example of the fist.

Learning to play the instrument should be based on knowledge of the basics of anatomy, and psychophysiology, in particular, the structure of the musculoskeletal system, the functioning of the muscular system, and the patterns of human movements. The knowledge gained by the students would allow for an understanding of the functions of the musculoskeletal system and the specifics of different muscle groups. Considering that each of them performs its own specific functions, their incorrect use or non-use during performance movements adversely affects both the sound quality and the development of technical skill.

Piano performance can be compared to the activity of athletes in terms of the intensity of using certain muscle and joint groups. Admittedly, achieving the desired result requires a lot of effort and training. Playing the piano involves frequently repeated movements of the fingers, forearms, elbows, etc. And, just like athletes, pianists face the risk of physiological injury. No musician is immune to this, regardless of whether they are a beginner or a professional performer. The wrong habits developed from the first lessons will become an obstacle to achieving a high technical level, but even if you are a brilliant performer, this does not mean that you have a safe technique and will not have serious medical problems in the future.

At the beginning of the 21st century, the problem of the danger of various kinds of injuries while playing the piano due to the ignoring of psychophysiological factors began to be actively raised by scientists from Western Europe, the USA, Asia, and Australia. However, in Ukraine, music pedagogy still focuses on the technical component of performance, without considering the connection between the human body structure, muscle functions and playing an instrument.

A similar idea was expressed in his dissertation by R. Niu (2020), which he devoted to the problem of technical education of pianists in China. It is a well-known fact that Chinese musicians demonstrate a high level of performance in the world, but the flip side of these successes remains unnoticed: the cost of winning competitions. The pursuit of great achievements becomes, in the scientist's

opinion, particularly traumatic for children: “students frequently develop movement habits that pose a danger to them in the future, as their play involves a combination of unnatural physiological techniques, frequent repetition of high-intensity exercises and ineffective technical postures.” It is hard to disagree with his opinion, as Ukraine is facing a similar situation. In fact, the problem is much deeper than it seems at first glance, as it is concerned with improving performance skills, and above all with the health consequences caused by mindless training. Repetitive Strain Injury, as noted by R. Niu (2020), result in numerous, sometimes chronic, musculoskeletal diseases. And to avoid this, it is easier to prevent their development than to treat them later.

L. Guseynova (2020), exploring the problem of improving the functional mobility of the student's playing apparatus in the piano class, considers “achieving muscle freedom and a sense of maximum comfort” to be the most important condition for the development of technique. The researcher emphasises the feeling of the weight of the hand, using game techniques that should be accompanied by a “muscular feeling of comfort”. Much attention is paid to ways to overcome technical difficulties, and the role of consciousness in this process is emphasised, especially when developing muscle memory in slow-paced exercises. Agreeing with the author, notably, these movements will become automatic if they are repeated identically. And this is only possible when a student understands what function certain muscles perform and can independently develop a specific algorithm for piano actions.

The importance of psychophysiological factors in the development of piano technique is emphasised by L.F. Rayo (2020), who notes that “when learning new skills, the brain and body must establish new connections between neurons for movements to become automatic”. The level of control over movements, in his opinion, is determined by making them automatic, and constantly improving the quality of this automaticity, when the process of mastering the technique is transformed into controlled and expressive work. It should be agreed with the author that this approach raises the quality of performance to a higher level: previously difficult movements become smoother and more harmonious, and the technique becomes not an end in itself but a means to achieve artistic purposes.

The results of many years of pedagogical and personal performance experience are reflected in B.A. Lister-Sink's doctoral dissertation (2015). An Australian researcher examined the effectiveness of an interdisciplinary method in mastering “trauma-preventive” piano technique. She notes that the number of cases where pianists become patients of orthopaedic surgeons, spine surgeons, and neurologists has increased. The reason for this, in her opinion, is “the existence of a correlation between injury and overuse/overstrain of muscles, chronic tension and stress on the joints”. The method of teaching developed by B. Lister-Sink was defined as an “alternative technical model”, which includes knowledge of neuropsychology, biomechanics, sports pedagogy, physiology of the performing arts, non-Western

pedagogy, in particular Tai Chi gymnastics. A separate point of this technique is using the Alexander Technique, a set of exercises named after the author and developer Frederick Matthew Alexander. Using this technique helps to rationally use the body's capabilities and harmoniously use muscles. As F.M. Alexander noted, "A person cannot get rid of problems unless they change their habits that will allow them to get rid of problems" (Who was F. Matthias Alexander?, 2020). The model developed by B. Lister-Sink demonstrated results that, according to the author, differ significantly from the conventional approach to technical development. The analysis of this thorough work, which contains a huge amount of interesting and useful information, certainly deserves a more detailed study and may become the subject of separate research.

CONCLUSIONS

The study of theoretical sources has allowed determining that the issue of psychophysiological factors in the development of the piano technique of future music teachers is still relevant. A retrospective analysis of scientific and pedagogical approaches to solving this problem allowed the developing of a universal theory based on practical experience. The cause-and-effect relationship between the performance shortcomings of piano students and the organisation of their motor activity, which consists in the lack of coordination of two interrelated and interdependent zones – power and playing, which determines the coherence of active and passive movements, is outlined. The criteria for the correct placement of the playing apparatus are determined, muscle groups and the specific features of their load during piano movements are classified. The

importance of self-control, self-regulation of motor activity in mastering the basic performance skills necessary for the successful performance of artistic and technical tasks is substantiated. Exercises are offered that help to rationally distribute the load on the muscles to avoid clamping of the arms and shoulders, relieve excess tension and achieve performance freedom. It is proved that the proposed approach to the development of piano technique, considering psychophysiological factors, allows consolidating the necessary sensations at the subconscious level and can provide students with self-control of the performance process. Psychomotor development, along with musical and auditory, emotional and volitional, etc., is the foundation for successful professional training of music teachers.

This research does not exhaust all the details of the problem and inspires further scientific discussion. Alexander Technique exercises, which help to relax muscles and promote coordination of movements, require a deeper study. In the world's leading music schools – the Juilliard School in New York, the Royal Academy of Music in London and Toronto, the Boston Conservatory, etc. – a course on these exercises is part of the educational process. This internationally recognised method is little known in Ukraine, and the effectiveness of its use in Piano Pedagogy for the harmonious development of performance skills is worth exploring.

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CONFLICT OF INTEREST

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REFERENCES

- [1] Bernshtein, N. (1967). *The coordination and regulation of movements*. Oxford: Pergamon Press.
- [2] Cherniak, Ye., & Zankova, S. (2017). Theoretical and practical aspects of the formation of the performing technique of the future instrumentalist. *Scientific Bulletin of Bohdan Khmelnytsky Melitopol State Pedagogical University. Series: Pedagogy*, 2, 144-148. doi: 10.7905/nvmdpu.v0i19.2386.
- [3] Gat, J. (1968). *The technique of piano playing*. London: Boosey & Hawkes Inc.
- [4] Grinchenko, A. (2022). On the problem of improving performance skills of future teachers in the process of playing the piano. *Pedagogy of creative personality formation in higher and general academic schools*, 81, 152-155. doi: 10.32840/1992-5786.2022.81.28.
- [5] Guseynova, L. (2020). Educational problems of improvement of the pianist's functional mobility of the performing apparatus. *Research Notes. Series "Psychology and Pedagogy Research" (Nizhyn Mykola Gogol State University)*, 1, 46-51. doi: 10.31654/2663-4302-2020-PP-1-46-51.
- [6] Guterman, V. (1984). *Return to creative life. Professional diseases of the hands*. Yekaterinburg: Humanitarian-ecological lyceum.
- [7] Hall, H. (2004). *A consultation with the back doctor*. Toronto: McClelland & Stewart.
- [8] Hirano, M., Kimoto, Y., & Furuya, S. (2020). Specialized somatosensory – motor integration functions in musicians. *Cerebral Cortex*, 30(3), 1148-1158. doi: 10.1093/cercor/bhz154.
- [9] Husak, V.A. (2013). *The specifics of the development of performance skills in the process of instrumental training of future music teachers*. *Scientific Journal of National Pedagogical Dragomanov University. Series 14: Theory and Methodology of Arts Education*, 19 (Part 1), 59-66.
- [10] Irkliienko, V., & Demyanko, N. (2019). Future teachers of musical art training during individual classes in major musical instrument. *Aesthetics and Ethics of Pedagogical Action*, 20, 119-127. doi: 10.33989/2226-4051.2019.20.171644.
- [11] James, B. (2018). Pianism: Performance communication and the playing technique. *Frontiers in Psychology*, 9, article number 2125. doi: 10.3389/fpsyg.201802125.

- [12] Kokun, O.M. (2006). *Psychophysiology*. Kyiv: Tsentr Navchalnoi Literatury.
- [13] Lister-Sink, B.A. (2015). *A study of students' perceptions of the effectiveness of an interdisciplinary method for teaching injury-preventive piano technique* (Doctoral thesis, Columbia University, New York, United States).
- [14] Mark, T. (2003). *What every pianist needs to know about the body*. Chicago: GIA Publications, Inc.
- [15] Martinsen, K. (1966). *Individual piano technique*. moscow: Muzyka.
- [16] Mazel, V. (2001). *The musician and his hands: Physiological nature and formation of the motor system*. Tel Aviv: Pilies Studio.
- [17] McLachlan, M. (2014). Prevention is better than cure. In *The foundations of technique* (pp. 7-22). London: Faber Music.
- [18] McLachlan, M. (2017). Development and health. In *The psychology of piano technique* (pp. 77-106). London: Faber Music.
- [19] Motuziuk, O.P., Khmelkova, A.I., & Mishchenko, V.I. (Eds). (2017). *Workshop on human physiology* (2nd ed.). Kyiv: Medicine.
- [20] Niu, R. (2020). *Types and causes of physiological injury in piano playing, with emphasis on piano pedagogy in China* (Doctoral thesis, School of Music, Morgantown, United States). doi: 10.33915/etd.7693.
- [21] Pozo, J.I. (2022). The psychology of music learning. In J.I. Pozo, M.P. Pérez Echeverría, G. López-Íñiguez, & J.A. Torrado (Eds), *Learning and teaching in the music studio* (pp. 47-83). Singapore: Springer. doi: 10.1007/978-981-19-0634-3_3.
- [22] Rayo, L.F. (2020). *Developing control in piano technique* (Doctoral project, Texas Tech University, Lubbock, United States).
- [23] Sradzhev, V. (1987). *Problems of the development of piano technique*. Tashkent: Fun.
- [24] Thio-Pera, A, De Carlo, M, Manzoni, A, D'Elia, F, Cerone, GL., Putame, G., Terzini, M., Gazzoni, M., Bignardi, C., & Vieira, T. (2022) Are the forearm muscles excited equally in different, professional piano players? *PLoS ONE*, 17(3), article number e0265575. doi: 10.1371/journal.pone.0265575.
- [25] Tseng, Y.-T., Tsai, C.-L., & Chen, F.-C. (2020). Wrist proprioceptive acuity is linked to fine motor function in children undergoing piano training. *Journal of Neurophysiology*, 124, 2052-2059. doi: 10.1152/jn.00282.2020.
- [26] Tsypin, G.M. (1984). *Learning to play the piano*. moscow: Prosveshcheniye.
- [27] Wang, B. (2010). The method of formation of performance technique of the future music teacher. *Scientific Bulletin of the South Ukrainian National Pedagogical University named after K.D. Ushynsky*, 7-8, 3-8.
- [28] Who was F. Matthias Alexander? (2020). Retrieved from <https://alexandertechnique.com/fma/>.
- [29] Ye Yang, Z. (2020). Modern piano teaching technologies: Accessibility, effectiveness, the need for pedagogues. *İlköğretim Online*, 19(3), 1812-1819. doi: 10.17051/ilkonline.2020.735171.
- [30] Zymohlyad, N.Yu. (2015). *Piano technique as the basis for the development of professional pianist*. *Scientific Journal of National Pedagogical Dragomanov University. Series 14: Theory and Methodology of Arts Education*, 19, 130-133.

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Психофізіологічні чинники ефективного розвитку фортепіанної техніки майбутніх музичних педагогів

Анотація. Результати успішного навчання студентів музично-педагогічної спеціальності на заняттях з фортепіано залежать від їхнього технічного рівня, володіння цілим комплексом навичок для втілення виконавських завдань. Однак ефективному розвитку перешкоджають психофізіологічні чинники, а саме: надмірне затиснення рук, невміння раціонально використовувати потрібні групи м'язів та збалансовано розподіляти навантаження на корпус. Мета дослідження – проаналізувати процес формування виконавських навичок через осмислення психофізіологічних особливостей. Методологічну основу склали праці українських та зарубіжних науковців, піаністів-педагогів. Для вирішення поставлених завдань було використано комплекс методів: аналіз, систематизацію, класифікацію, узагальнення педагогічного досвіду. Для окреслення технічних виконавських проблем і способів їх вирішення було використано описовий і дидактичний методи; для перевірки і підтвердження ефективності вибраної методики – метод педагогічного спостереження. У статті наголошено на ключових моментах корекції постановки корпусу, що допомагають позбутися надмірної скованості рухів, перенапруження слабших м'язових груп і позитивно впливають на розвиток виконавської свободи. Це насамперед правильна посадка за інструментом, виховання відчуття ваги руки в спокійному стані і під час підйому. Запропоновано апробовані вправи, що забезпечують фіксацію оптимальних м'язових відчуттів у ділянці плечового пояса, особливо в зоні лопатки і плечового суглоба, під час різних рухів руками. Іншою поширеною проблемою визначено недостатню увагу до функціонування м'язів-розгиначів пальців, що перешкоджає розвитку їхньої вправності та самостійності і є причиною затисненості зап'ястка. Обґрунтовано важливість виховання в студентів усвідомленого оволодіння первинними руховими навичками на базі конкретних м'язових відчуттів. Результати дослідження доводять, що визначений алгоритм дій у постановці ігрового апарату та виправленні недоліків здатний забезпечити стабільність виконавської свободи, самоконтроль і саморегуляцію рухових дій

Ключові слова: музична педагогіка; формування технічних навичок; організація ігрових рухів; напруженість і розслабленість м'язів; посадка за інструментом; самоконтроль рухових дій