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THE IMPORTANCE OF THE DEVELOPMENT OF VESTIBULAR APPARATUS FOR THE FORMATION OF ORAL SPEECH FOR HEARING-IMPAIRED CHILDREN USING VERBOTONAL METHOD

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Abstracts

Topicality. Today there are many different approaches to upbringing and educate hearing-impaired children in the world. The verbotonal method is one of the alternative systems for rehabilitation of hearing-impaired children, what is fundamentally different from traditional approaches. This method provides for a simultaneous development of all sense organs, does not offer to isolate a specific kind of perception, nor exaggerating the role of a particular stimulus or replacement with other linguistic code. The main task of the method is a harmonious development of the child, his preparation for social adaptation and integration, taking into account individual abilities. **The purpose of the research** was to highlight the developmental characteristics of the vestibular apparatus for the formation of oral speech in hearing-impaired children using verbotonal method. **Materials** 40 preschool-age children were examined. Main group 1 (MG1) included 21 children aged 5,2±0,1 years old (10 boys, 11 girls), control group (CG1) included 19 children. **Results.** The results of children rehabilitation based on the results of valuation of psychomotor development are presented. The method is complex and includes the following elements: status of hand-eye coordination, speed and precision in movements, development of perception, visual memory, assessment of auditory development and coordination. **Conclusions.** It is determined that development of vestibular apparatus plays an important role in the development of oral speech and is aimed at restoring audiolingual skills for normal functioning of individual. It is recommended that in the rehabilitation process it is necessary to pay special attention to integral and harmonious development of personality, restoration of intellectual development, physical, mental and verbal growth of the child based on his potential abilities. Timely and well-organized rehabilitation work ensures the proper development of the individual and promotes rapid socialization of the child.

Key words: hearing impairment, vestibular apparatus, oral speech, rehabilitation.

Ольга Заставна. Значення розвитку вестибулярного апарату для формування усного мовлення в дітей із порушенням слуху за верботональною методикою. Актуальність дослідження. На сьогодні у світі існує багато різних підходів до виховання й навчання дітей із порушеннями слуху. Однією з альтернативних систем реабілітації дітей із порушеннями слуху, що принципово відрізняється від традиційних підходів, є верботональна методика. Вона передбачає одночасний розвиток усіх органів чуття, не пропонує ізолювати окремих вид сприйняття, не перебільшує роль певного стимулу або заміну іншим лінгвістичним кодом. Основним завданням методики є гармонійний розвиток дитини, її підготовка до соціальної адаптації та інтеграції, урахування індивідуальні здібності. **Мета дослідження** – висвітлення особливостей розвитку вестибулярного апарату для формування усного мовлення в дітей із порушенням слуху за верботональною методикою. **Матеріали методи дослідження.** Аналіз наукових джерел, зорово-моторної координації, швидкості й точності рухів, розвитку сприйняття, зорової пам'яті, оцінки слухового розвитку, координації. Обстежено 40 дітей дошкільного віку. Основну групу 1 (ОГ1) склала 21 дитина віком 5,2±0,1 роки (10 хлопчиків, 11 дівчат), контрольну (КГ1) – 19 дітей. Критеріями виключення було пацієнти з аутичним спектром та розумовою відсталістю. **Результати.** Представлено результати реабілітації дітей на основі результатів оцінки психомоторного розвитку. Методика має комплексний характер і включає такі елементи, як стан зорово-моторної координації, швидкість і точність рухів, розвиток сприйняття, зорової пам'яті, оцінка слухового розвитку, координації. **Висновки.** Визначено, що розвиток вестибулярного апарату відіграє важливу роль у розвитку усного мовлення й спрямований на відновлення слухомовних навиків для нормального функціонування індивіда. Показано, що в процесі реабілітації потрібно приділяти особливу увагу цілісному гармонійному розвитку особистості, відновленню інтелектуального розвитку, фізичного, духовного та мовного зростання дитини на основі її потенційних здібностей. Своєчасна та правильно організована реабілітаційна робота забезпечує належний розвиток індивіда й сприяє швидкій соціалізації дитини. Перспективу подальших

досліджень убачаємо в розробці реабілітаційних заходів для цього контингенту хворих з використанням верботональної методики.

Ключові слова: порушення слуху, вестибулярний апарат, усне мовлення, реабілітація.

Ольга Заставна. Значение развития вестибулярного аппарата для формирования устной речи у детей с нарушением слуха по верботональной методике. Актуальность исследования. На сегодняшний день в мире существует много различных подходов к воспитанию и обучению детей с нарушениями слуха. Одной из альтернативных систем реабилитации детей с нарушениями слуха, принципиально отличающейся от традиционных подходов, является верботональная методика. Данная методика предполагает одновременное развитие всех органов чувств, не предлагает изолировать отдельный вид восприятия, не превышает роль определенного стимула или замену другим лингвистическим кодом. Основной задачей методики является гармоничное развитие ребенка, ее подготовка к социальной адаптации и интеграции, учитывая индивидуальные способности. **Цель** исследования – освещение особенностей развития вестибулярного аппарата для формирования устной речи у детей с нарушением слуха по верботональной методике. **Материалы методы исследования** – анализ научных источников, зрительно-моторной координации, скорости и точности движений, развития восприятия, зрительной памяти, оценки слухового развития, координации. Обследовано 40 детей дошкольного возраста. Основную группу 1 (ОГ1) составил 21 ребенок в возрасте $5,2 \pm 0,1$ года (10 мальчиков, 11 девочек), контрольную (кг1) – 19 детей. Критериями исключения были пациенты с аутичным спектром и умственной отсталостью. **Результаты.** Представлены результаты реабилитации детей на основе результатов оценки психомоторного развития. Методика имеет комплексный характер и включает следующие элементы: по состоянию зрительно-моторной координации, скорости и точности движений, развитию восприятия, зрительной памяти, оценки слухового развития, координации. **Выводы.** Определено, что развитие вестибулярного аппарата играет важную роль в развитии устной речи и направлено на восстановление слуховых навыков для нормального функционирования индивида. Показано, что в процессе реабилитации нужно уделять особое внимание целостному гармоничному развитию личности, восстановлению интеллектуального развития, физического, духовного и языкового роста ребенка на основе его потенциальных способностей. Своевременная и правильно организованная реабилитационная работа обеспечивает надлежащее развитие индивида и способствует быстрой социализации ребенка. Перспективой дальнейших исследований видим разработку реабилитационных мероприятий для данного контингента больных с использованием верботональной методики.

Ключевые слова: нарушение слуха, вестибулярный аппарат, устная речь, реабилитация.

The purpose of the research was to highlight the developmental characteristics of the vestibular apparatus for the formation of oral speech in hearing-impaired children using the Verbo-Tonal method.

Today there are many different approaches to upbringing and educate hearing-impaired children in the world. The Verbo-Tonal method is one of the alternative systems for rehabilitation of hearing-impaired children, what is fundamentally different from traditional approaches. This method provides for a simultaneous development of all sense organs, does not offer to isolate a specific kind of perception, nor exaggerating the role of a particular stimulus or replacement with other linguistic code. The main task of the method is a harmonious development of the child, his preparation for social adaptation and integration, taking into account individual abilities.

Materials 40 preschool-age children were examined. Main group 1 (MG1) included 21 children aged 5.2 ± 0.1 years old (10 boys, 11 girls), control group (CG1) included 19 children.

Results. The results of children rehabilitation based on the results of valuation of psychomotor development are presented. The method is complex and includes the following elements: status of hand-eye coordination, speed and precision in movements, development of perception, visual memory, assessment of auditory development and coordination.

Conclusions. It is determined that development of vestibular apparatus plays an important role in the development of oral speech and is aimed at restoring audiolingual skills for normal functioning of individual. It is recommended that in the rehabilitation process it is necessary to pay special attention to integral and harmonious development of personality, restoration of intellectual development, physical, mental and verbal growth of the child based on his potential abilities. Timely and well-organized rehabilitation work ensures the proper development of the individual and promotes rapid socialization of the child.

Key words: hearing impairment, vestibular apparatus, oral speech, rehabilitation.

Introduction. One of the most serious health and social problems is diseases leading to hearing decrease or loss. Given that acoustic analyzer is one of the most informative in respect of receipt of

information from the outside world, decrease of hearing, not to speak about its loss, significantly affects the quality of life, violating a person's position in society, restricts his/her choice of profession, and often leads to exclusion from society. Hearing is also important for the overall development and personality formation, in particular, for child's speech development, which has a decisive influence on his mental development (N.G. Baykina, A.V. Mutiev, Y.V. Kret, 2003; L.S. Vygotsky, 2003) [7].

In Ukraine, upon the results of epidemiological studies, 1 child is born with total deafness per 1,000 normal births; deafness develops in 2-3 children during the first 2 years of life. There are about 300 thousand children and 1 million adults with hearing impairment in the state, who require a hearing aid, including with deafness — 11 million children and 100 thousand adults (B.S. Moroz, A.T. Rostunov, 2013; V.M. Shevchenko, 2013) [9; 10].

Today there are many different approaches to upbringing and educate hearing-impaired children in the world. The Verbo-Tonal method is one of the alternative systems for rehabilitation of hearing-impaired children, what is fundamentally different from traditional approaches. This method provides for the simultaneous development of all sense organs, does not offer to isolate a specific kind of perception, nor exaggerating the role of a particular stimulus or replacement with other linguistic code. The main task of method is the harmonious development of the child, his preparation for social adaptation and integration, taking into account individual abilities.

At present, no one denies the importance of early diagnosis and rehabilitation of hearing-impaired children. It is important to begin rehabilitation immediately after establishing diagnosis for a child.

As the whole children's organism, their body and musculoskeletal and vestibular apparatus play an enormous role in rehabilitation, it is necessary to conduct a precise examination of vestibular organ. It is important to check the function of vestibular apparatus before the rehabilitation beginning. There is a special apparatus for this, but if it is not possible to use such devices, you can refer to the fairly simple well-known methods.

Coordination of movements is investigated by using the tests corresponding to the age at which the child can perform them:

- finger-nose test: children with their index finger touch a nose tip in turn, by different hands with visual, and then without visual control, spreading arms out to the sides. The researcher notes mistouches;
- heel-knee test: the heel of one foot slides down along the low leg from the knee to the foot of another leg, and then up to the knee. The heel slides off the lower leg in pathology;
- test for mistouche: the child under test must hit with the finger the immovable finger of the researcher (with visual and without visual control in horizontal and vertical planes). The mistouche is recorded on the side of defect;
- diadochocinesia: the opposite (supination and pronation) movements are performed by stretched out hands with splayed fingers at a fast pace. The movements` symmetry is disordered in pathology, they become clumsy;
- studying the walking, the rocking, the steadiness of steps and the symmetry in movements of the whole body are observed. Coordination of movements is also studied using coordinamometre of different types. [5]

The principal pathology can cause a chain of consequences, which, having arisen, become causes of new disorders. It was revealed that hearing loss in children is accompanied by disharmonious physical development in 62% of cases, in 43.6% - by defects of musculoskeletal apparatus (scoliosis, flatfoot etc.), in 80% of cases - by delay in motor development. Comorbidities are observed in 70% of deaf children. Hearing-impaired children have retardation development of locomotor static functions, which, in turn, affects the formation of inter-analyzer connections. Retardation development of "straight standing" (mastery of sitting, walking, etc.) leads to disorientation in space and in the objective world.

The Verbo-Tonal Method (VTM) attaches great importance to the development of the vestibular apparatus, the body movements and orientation in space for the formation of oral speech in hearing-impaired children. The principle of the Verbo-Tonal Method is the following: "An auditory nerve of a deaf child is damaged, the auditory center in the cerebral cortex is not damaged, and however, it never receives auditory signals. The task of the Verbo-Tonal Method is to make the auditory center to work".

The purpose of the research was to highlight the developmental characteristics of the vestibular apparatus for the formation of oral speech in hearing-impaired children in the rehabilitation center for children with hearing and speech disorders using Verb-Tonal method.

The methods of the research.

40 preschool-age children were examined. Main group 1 (MG1) included 21 children at the age of 5.2 ± 0.1 (10 boys, 11 girls), who were registered with the rehabilitation center for children with hearing and speech disorders of Ivano-Frankivsk Regional Children's Consultative Clinic. The control group (CG1) involved 19 children, who were registered with the pediatrician of Ivano-Frankivsk Regional Children's Consultative Clinic.

Table 1

The development of hand-eye coordination of hard-of-hearing children (M \pm m)

| Indicator | CG (n=19) | MG1 (n=21) |
|---------------------------------------|------------------|-------------------|
| The level of hand-eye coordination | | |
| High | 30 \pm 7.25 | |
| Normal | 70 \pm 7.25 | 42.86 \pm 10.8* |
| Low | | 57.14 \pm 10.8* |
| The level of motor skills development | | |
| Indicator | CG (n=19) | MG1 (=21) |
| High | 45 \pm 7.87 | |
| Medium | 55 \pm 7.87 | 33.33 \pm 10.3* |
| Low | | 66.67 \pm 10.3* |
| Picking up a pyramid, s | 8.46 \pm 14 | 12.15 \pm 0.45* |
| Tapping test, number of dots | 28.42 \pm 0.79 | 19.57 \pm 1.25* |

Table 2

The development of Visual Memory of hard-of-hearing children(M \pm m)

| Indicator | CG (n=19) | MG1 (n=21) |
|----------------|-----------------|-------------------|
| Performed | 87.5 \pm 5.23 | 28.57 \pm 9.86* |
| Not performed | 12.5 \pm 5.23 | 71.43 \pm 9.86* |
| Auditory sense | | |
| Performed | 100 | |
| Not performed | | 100* |

Table 3

The level of functional state of hard-of-hearing children(M \pm m)

| Indicator | CG (n=19) | MG1 (n=21) |
|---------------------|------------------|------------------|
| String Test | | |
| Boys | 10.84 \pm 0.74 | 5.34 \pm 0.35* |
| Girls | 11.32 \pm 0.88 | 5.69 \pm 0.41* |
| Tree Test, s | | |
| Boys | 7.33 \pm 0.27 | 3.37 \pm 0.12* |
| Girls | 7.15 \pm 0.74 | 3.15 \pm 0.09* |

Notes: * – statistically significant difference in comparison with the corresponding indicator of CG ($p < 0.05$);

○ - statistically significant difference in comparison with the appropriate indicator of MG1 ($p < 0.05$)

The results of the research. As the whole child's organism, his body, movements and vestibular apparatus play a great role in rehabilitation, it is necessary to conduct a precise examination of vestibular organ. The vestibular apparatus is the organ perceiving changes in head and body positions in space and in directions of human body movements. It is a part of the inner ear and is a complex receptor of the vestibular analyzer.

The signals of two types are transferred from receptors, namely: static and dynamic. They both appear in the course of mechanical stimulus of hairs sensitivity as a result of otoliths or endolymph displacement. When changing body position, the direction of the force is changed, that acts from the otolith side on the hairs sensitivity. Utricle plays a leading role in perceiving a body position and probably is involved in rotation perception. Saccule complements the utricle and is required for perception of vibration.

Inner ear parts innervate with eighth cranial nerve processes of which end either in the auditory or in the vestibular nuclei of the brain, where the received information is analyzed. The vestibular nucleus is a nerve cell cluster in the brain stem; they have a wide range of connection with skeletal apparatus, eye muscles and cerebral cortex. Nerve impulses are transmitted from the vestibular nucleus to the temporal part of the cerebral cortex, where the center of balance and the sense of control consciousness over the head and body positions are located. The balance is determined and maintained by the center of the brain, which receives information from the organs of equilibrium located in the inner ear and other sense organs. Thus, the brain receives the signals coming from the vestibular apparatus with information perceived by eyes and other sense organs [2; 4].

Embryonic vestibular organ appeared as a result of thickening of the exodermis, meanwhile, specific sensory cells (mechanoreceptors) were developed. The vestibular organ has otolithic and cupular sense organs. Sensitive cells of otolithic organ perform the following functions: 1 – perception of gravitational field; 2 – perception of linear acceleration; 3 – perception of angular acceleration; 4 – response to the sound. The cupular organ contributes to angular acceleration. Neurophysiological studies have proved that otolith organ responds to tones of 1,000 Hz and can replace cochlear activity. While the inner ear contains both the vestibular apparatus and cochlear, we can talk about vestibulocochlear hearing. [4]

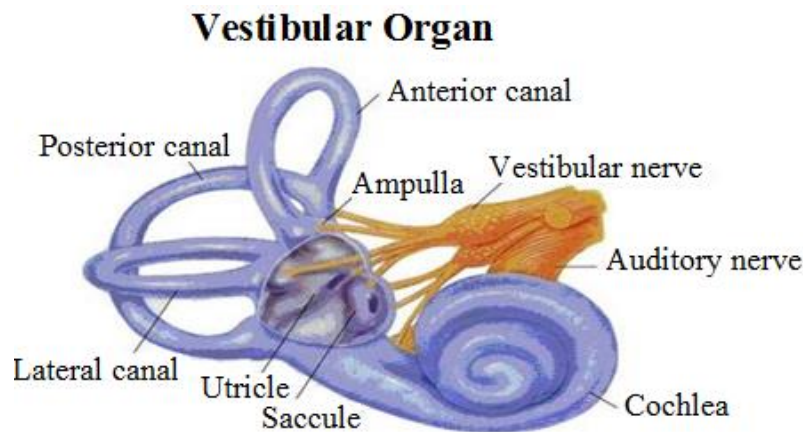


Fig. 1. *The vestibular organ is composed of otoconia apparatus, formed by the utricle and the saccule, and three semicircular canals*

The vestibular sense improves speech understanding, as the changes in intonation, rhythm, pace and values of oral speech are perceived by it (Fig.1) through low frequencies. Vestibular perception coincides with the auditory at frequencies from 16 Hz to 1,000 Hz. Frequencies below 16 Hz are perceived only by the vestibular apparatus. The thresholds of the vestibular organ are unknown, because it is difficult to separate auditory perception from vestibular one. Sensory perception of information in the vestibular nucleus is also transferred to the reticular formation, the cerebellum and the lateral auditory pathway [1].

When the hearing is impaired, perception depends on other biological mechanisms, such as sense in space. The brain regulates the magnitude and precision of movements. If there are disorders in the vestibular organ, other organs (vision, hearing, and tactile feelings) assume its functions and vice versa. Recovery of vestibular apparatus function is very important for the rehabilitation. It is required for orientation in space. It is necessary to teach hearing-impaired children movements, the ability to control their body, that is to strain and relax. If the child only lost hearing, without accompanying disorders of the vestibular apparatus and motor skills of the body, rehabilitation is carried out easier and more successful.

The in hereditary deaf children usually have vestibular apparatus in the normal condition. But, along with it, most of hearing-impaired children have vestibular function disorders. This is especially common in children, who suffered through purulent meningitis, as a result, the labyrinth can be damaged and vestibular function can be affected. It was found that the damaged labyrinth is more common in people with acquired deafness [3].

Disorders of coordination, movements when walking, symptoms of body sway and walk extending the foot on the surface is observed in deaf people with disordered vestibular apparatus. But the balance in respect

of them is gradually formed due to visual perception of the environment, and the feeling of their own body, their movements, and kinetic senses when moving. The role of vestibular senses is great not only for preserving a balance but also for orientation in space. And for hearing-impaired children the vestibular apparatus plays an important role in rehabilitation for full socialization.

The great importance in rehabilitation of children using the Verbo-Tonal method is paid to the development of vestibular function. It provides for exercises, namely: jumping on one and two legs, jumping over certain hurdles or the cord, walking along the line or on the gymnastic bench, swinging, counting rhymes with hand movements, etc. Educators and parents who are walking with a child, must encourage him to physical activity, as well as to a variety of play-based tasks aimed at the formation of vestibular sense.

The following exercises are used by the rehabilitation center for children with hearing and speech disorders for the development of vestibular function when working with children of different age groups.

Exercises for young children (1-3 years old):

- walking with things in hands;
- rolling on the floor on a mat;
- walking along the gymnastic bench (hands behind head), by sidesteps alternately by the left, the right side, dismount into the hoop.

Exercises for infants and pre-school children:

- walking along a narrow rail of gymnastic bench (hands to the sides), dismount into the hoop. Walking along a narrow rail of gymnastic bench (hands behind head) squats in the center, then continuing in movement (with the use of audio signal - by ear);

- jumping on the fitball in a sitting position, holding the balance.

Exercises for older pre-school-age children:

- jumps on both feet through the gymnastic bench with the leaning upon hands (three sets);
- walking on a brick (tambourine beating with every step), then "the beating frequency is changed, increasing the speed of steps;
- a cotton ball tossing and catching (10 times in a row);
- raising the body from a facedown position on a fitball, first hands behind head, then to the sides (10 times, count 1-2).

Exercises for school-age children:

- perform arabesque on the floor, then on the gymnastic bench;

P. P.: standing on the floor with eyes closed, lift your right leg, bending its knee, and touching with your left hand the nose tip; repeat with the other leg;

- keep balance sitting on a fitball (hands to the sides, legs pressed to the ball).

The results of the research. Therefore, the Verbo-Tonal method opens new opportunities for the person. This work is carried out in a specific sequence and consists of the following three stages: diagnosis, rehabilitation and integration. This method gives the opportunity to develop hearing in deaf children using the bodily conductivity of low frequencies, to which every living organism is sensitive, as well as residual of auditory senses.

Definition of psychomotor development of hard-of-hearing children found that they slow down behind their healthy children of the same age in terms of hand-eye coordination, speed and precision of movements, development of perception, visual memory, assessment of auditory development and coordination (See Tables 1, 2, 3).

In determining the state of hand-eye coordination using Seguin Form Board Test, it is found that during initial examination of hard-of-hearing children no individuals with its high level were identified (compared to one third in CG) ($p < 0.05$). The normal level was determined only in $30 \pm 7.25\%$ of CG children and $42.11 \pm 11.33\%$ of MG1, low – $57.14 \pm 10.8\%$ ($p > 0.05$), respectively.

The children with a high level of manual fine motor skills were not identified among hard-of-hearing children in both groups, while in the group of children with normal hearing there were nearly half of them. The average level of development of motor skills was detected only in one-third of hard-of-hearing children, most of which has its low level (See Table 1).

In order to determine the level of finger coordination development, the test 'pick up the pyramid' was carried out. The test time in CG was 8.46 ± 0.14 s, i.e. it was on average by 42.7% less than in the main group, which indicates the deterioration of fine motor skills in hard-of-hearing children.

The results of the tapping test became the proof of the latter fact: number of dots in CG was, on average, by 32.4% more than in the main group, indicating a poor state of visual-motor coordination of deaf children (See Table 1).

The definition of visual memory by means of putting together the cut picture in 30 s showed that only one third of hard-of-hearing children coped with this task, what significantly differed from the indicator of children with preserved hearing (87.5 ± 5.23) ($p < 0.05$).

The level of development of auditory perception was determined as unconditional reflex audiometry. Under this option the children of main groups were also retarded from the children of the same age. ($p < 0.05$) (See Table 3).

The results of carrying out String Test, which, together with Tree Test determine the level of functional state of central nervous and musculoskeletal systems, showed that both boys and girls of main groups kept a balance approximately twice less time compared to CG indicator ($p < 0.05$). A similar trend was determined in carrying out the Tree Test (steadiness to hold the body on one leg) (See Table 4).

Conclusions and prospects for further research. The Verbo-Tonal method is rehabilitation of child's harmonious development, primarily rehabilitation of residual hearing perception with activation of all preserved analyzers, potential capacities of children. The fundamental in the Verbo-Tonal teaching method is that the patient's speech develops on the basis of residual auditory perception. A basic and fundamentally important in the Verbo-Tonal method of teaching and upbringing children with hearing and speech disorders is what primarily directly affect the brain through auditory analyzer. The brain will function better if it gets first auditory stimulus, for which ear is the most sensitive, and, secondly, through vision and other analyzers. The brain will recover its functions. Therefore, it is important to train hearing, to develop auditory sense through the vestibular apparatus. This is because the development of vestibular apparatus is of great importance in the formation of oral speech in hearing-impaired children using the Verbo-Tonal method.

The main goal of Verbo-Tonal method is hearing and speech rehabilitation, development of all abilities of the child and preparation for social adaptation and integration, taking into account individual characteristics of the child.

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