

## Integrating sensory pedagogy into work with children with visual impairments

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Опубліковано	Секція	УДК
30.12.2025	<i>Освіта</i>	376.33:37.013.82

DOI: <https://doi.org/10.5281/zenodo.20431104>

**Анотація.** Стаття присвячена інтеграції сенсорної педагогіки через ігрові методики для розвитку сенсорної обробки, просторового мислення та емоційно-поведінкових навичок у дітей з порушеннями зору. Використання аудіотактильних, моторних та мультисенсорних вправ сприяє розвитку компенсаторних здібностей та підвищує самостійність та впевненість дітей у взаємодії з навколишнім середовищем.

Метою дослідження було оцінити ефективність інтеграції сенсорної педагогіки через ігрові методики у розвиток сенсорної обробки, просторового мислення та емоційно-поведінкових навичок у дітей з вадами зору. У дослідженні взяли участь 90 дітей з вадами зору віком від 4 до 8 років та 90 дітей контрольної групи з нормальною гостротою зору. Використовувалися спеціально підібрані дидактичні та аудіотактильні вправи, а також ігри на відтворення поз, просторове розташування предметів за допомогою словесних інструкцій та мультисенсорні вправи, що поєднують слухові, тактильні, нюхові та моторні стимули.

Результати підкреслюють необхідність індивідуального підходу до вибору завдань, поступового ускладнення вправ та поєднання різних сенсорних стимулів для досягнення оптимального освітнього ефекту. Впровадження сенсорних ігор у навчальний процес може бути цінною підтримкою для дітей з вадами зору у дошкільному та шкільному закладах, тим самим сприяючи їхній соціалізації та гармонійному розвитку. Для оцінки сенсорної обробки було використано адаптований сенсорний профіль, який дозволив оцінити слухові, тактильні, вестибулярні та мультисенсорні функції, а також модуляцію сенсорних сигналів, емоційно-поведінкові реакції та просторову орієнтацію. Результати показали, що діти з вадами зору, які беруть участь у сенсорних ігрових заняттях, значно покращили свої навички слухової, тактильної та мультисенсорної обробки, а також здатність модулювати свої рухові та емоційні реакції та розвивати просторове мислення порівняно з нормативними даними в контрольній групі. Було продемонстровано, що ігрові сенсорні методи призводять до виникнення компенсаторних здібностей у дітей з вадами зору та сприяють самостійності, впевненості в собі та адаптації до навколишнього середовища, а також соціальній інтеграції та розвитку творчого потенціалу. Результати підтверджують доцільність інтеграції сенсорних ігор у дошкільну та шкільну освіту для допомоги дітям з вадами зору та підкреслюють важливість індивідуалізації навчальних завдань на основі сенсорних особливостей кожної дитини.

**Ключові слова:** сенсорна педагогіка, порушення зору, дидактичні ігри, просторове мислення, сенсорна модуляція, компенсаторні здібності, інтерактивні заняття.

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## INTEGRATING SENSORY PEDAGOGY INTO WORK WITH CHILDREN WITH VISUAL IMPAIRMENTS

**Annotation.** The article is devoted to integrating sensory pedagogy through game techniques to develop sensory processing, spatial thinking, and emotional-behavioural skills in children with visual impairments. The use of audio-tactile, motor, and multisensory exercises contributes to the development of compensatory abilities and enhances children's independence and self-confidence in their interactions with the environment.

The purpose of the study was to evaluate the effectiveness of integrating sensory pedagogy through playful methodologies in the development of sensory processing, spatial reasoning, and emotional-behavioural skills in visually impaired children. The research involved 90 visually impaired children aged 4 to 8 years and 90 children from the control group with normal visual acuity. Specifically selected didactic and audio-tactile exercises were used, as well as games of pose reproduction, spatial arrangement of objects by verbal instruction, and multisensory exercises combining auditory, tactile, olfactory, and motor stimuli.

The results emphasise the necessity of an individual approach to task selection, gradual complication of exercises, and the combination of different sensory stimuli to achieve the optimal educational effect. The introduction of sensory games into the educational process can be a valuable support for children with visual impairments in preschool and school education, thereby contributing to their socialisation and harmonious development. To assess sensory processing, an adapted Sensory Profile was used, which allowed auditory, tactile, vestibular, and multisensory functions to be assessed, as well as sensory signal modulation, emotional-behavioural reactions, and spatial orientation. Results indicated that visually impaired children participating in sensory play sessions significantly improved their auditory, tactile, and multisensory processing skills as well as their ability to modulate their motor and emotional reactions and develop spatial thinking abilities compared with the normative data in the control group. It was demonstrated that playful sensory methods lead to the emergence of compensatory abilities in visually impaired children, and promote self-reliance, self-confidence, and adaptation to the surrounding environment, as well as social integration and the emergence of creative potential. The findings confirm the expediency of integrating sensory games in preschool and school education to assist visually impaired children and emphasise the importance of individualising learning tasks based on each child's sensory peculiarities.

**Keywords:** sensory pedagogy, visual impairment, didactic games, spatial thinking, sensory modulation, compensatory abilities, interactive activities.

### Вступ (Introduction)

The contemporary educational system is facing the challenge of providing equal access to quality education for all children, including those with visual impairments. Sensory-spatial education is often insufficient in traditional teaching methods, making it difficult to involve such children in the educational process fully. At the same time, sensory pedagogy opens new opportunities for developing compensatory mechanisms, forming spatial representations, and stimulating cognitive activity in children with visual system disabilities. The use of tactile, auditory, and olfactory stimuli not only compensates for the absence or limitation of the visual analyser but also enriches the educational experience and activates cognitive processes. However, in practice, the implementation of sensory methods in preschool and school education remains fragmentary, often lacking a systemic approach and appropriate adaptation of exercises and games to students' individual needs. This determines the need for scientific substantiation and methodological improvement of the integration of sensory pedagogy into the work with visually impaired children.

Traditionally, sight is considered the primary channel of perception through which a human receives most of the information about the surrounding world. It is mainly through the visual system that a child, from the very first years of life, actively explores the environment, orients in space, forms concepts of objects, and develops social skills. However, in children with visual impairments, this mechanism is limited or absent, requiring the involvement of other sensory systems - auditory, tactile, olfactory, and proprioceptive - for effective perception and interaction with the world.

The combination of several sensory channels enables increased accuracy and speed in information processing and serves an important compensatory function. However, inadequate visual stimulus may also impede the processing of sensory signals and result in uneven processing of stimuli. Children with visual impairment frequently show heightened or reduced sensitivity towards the stimuli of the organs of sensation that are preserved. For example, signal perception from muscles or joints may not be high enough to produce accurate signals, body position in space may not be well defined, focus on the most important auditory and tactile cues may be difficult. In such cases, additional sensory stimuli need to be provided to the child, but without vision, the options for compensation are limited. Different sensory responses affect the development and behaviour of children with visual impairments. Poor sensory integration can look like a hypersensitivity to touch, avoidance of certain things or stereotyped movements e.g., rocking of the body, eye pressing or always rubbing. Such activities have a kind of regulatory role that they can play: They help a child to stay on track when stimulated by certain stimuli. They can also interfere with learning, reduce social engagement, and cause misunderstandings among friends and adults putting the child at increased risk for social withdrawal. Sensory modulation is the capability to adapt one's perception of the present situation adequately and flexibly in response to the stimuli. For each child, but differentially to neurophysiological properties, also of behavioural strategies. Most children tend to respond moderately to sensory stimuli, and do not require disruption to daily life. Other visually impaired students show overly strong and weak responses, which is detrimental to their schooling, daily activities, and social relationships. It is important to study the sensory profiles of this group of children to be able to identify risk signs at an early and timely stage and to be able to design appropriate pedagogical and corrective interventions. By learning how visual impairment impacts the sensory experiences of the visually impaired child, teachers can better develop the learning environment by being made aware of how the visually impaired child perceives/integrates sensory inputs, so teachers, psychologists and parents can improve the learning environment, utilize special sensory techniques and support the child's well-balanced development. Recent studies from science literature have demonstrated increasing interest in establishing inclusive educational settings for visually impaired children by integrating play with multimodal, touch and sound systems. Interactive devices that assist spatial perception, memory, and cognitive skills in children with visual impairment must have prominent role in this process of education and socialisation. One of the leading research areas is the development of online interactive materials adapted for the learning problems of visually impaired children. Bairagi N., Gupta M., Acharya S. highlights the importance of formulating best-in-class design criteria for interactive storybooks with attention to touch perception, content, and user-interface context as part of the requirements in students' education in India [1]. Similarly, the potential of co-designed mini-games for visually impaired children was explored which show that co-design provides ease-of-use and hence learning through play [2]. According to Castaneda J. A. C. and coauthors in STEM education, an approach to educational solutions that not only acknowledge the visual constraints of children but are also playful and inclusive involves actively participating in learning [3]. Thus similar to the approach taken in the present study, Hewett, R., Cobb, R., Keil, S., McLinden, M., and Douglas, G. provide a pathway of balanced learning which ensures equal access to education for visually impaired learners and integrates academic knowledge with life skills development [4].

The research also focuses on the significant impact that games and digital tools have on low resource settings. However, teachers in schools for the blind in low-resource countries perceive digital games as instrumental as an additional learning platform positively [6]. At the same time, they also highlight several technical and pedagogical difficulties [6]. 3D modeling and tactile technology in adaptive education is extremely crucial. Minatani, K., and Watanabe, T. presented the establishment of an online symposium with 3D tactile models for facilitating access to physical materials for visually impaired children [7]. Wu H found that introducing 3D printing and tactile graphic tools could enhance students' drawing and spatial imagination skills, where they are much better able to practice their skills [15].

Multisensory approaches, in particular the Montessori method, have been shown to promote cognitive and spatial learning. Ogbemudia I.M., Alasa, V.M., and Ikenyiri, J.C. emphasise the importance of engaging multiple sensory channels touch, hearing, and movement for deeper learning [8]. Othman, N. I., Mohamed, H., & Mat Zin, N. A. suggested a model for designing serious games for visually impaired children focusing on accessibility and adaptability [9], while the earlier research by this authors identified the main features of such games, including high contrast, clear audio signals, and simplified navigation [9].

Considerable attention is also given to the pedagogical conditions of sensory development. Vilkhova O. and Hryshko O. demonstrated that using didactic games in preschool age stimulates sensory education and lays the groundwork for the development of spatial thinking [14]. Prokopchuk N. insists that sensory integration is an effective way of working with children who have sensory dysfunctions, as it contributes to the development of compensatory mechanisms and formation of spatial orientation [12]. Turko B. and Zhmurko T. state that interactive teaching methods increase children with special educational needs' motivation and facilitate the adaptation of the material to students' individual capabilities [13].

The use of multimodal educational tools is equally important in specialised educational institutions. Zhu et al. explored the practice of usage of accessible technologies in "blind colleges" and discovered that students face difficulty in accessing adaptive materials; however, the use of special interfaces and technologies greatly enhances the learning experience [17]. Zhang B., Qiu Y., and Tian Y. developed a multisensory educational toy that facilitates cognitive development and interaction among children with disabilities [16]. Phutane M. and coauthors likewise emphasise the importance of tactile materials in teaching practice, especially from the perspective of the teacher's experience and the student's reception [11].

Together, these studies provide evidence that the implementation of interactive, tactile, and multisensory technologies creates an effective learning environment for the visually impaired children. These methods do not merely compensate for the visual deficit, but also encourage the development of spatial thinking, memory, and social-communicative skills.

The purpose of the work was to investigate the effectiveness of integrating sensory pedagogy through game methodologies in the development of sensory processing, spatial thinking, and emotional-behavioural skills in visually impaired children.

**Methodology.** Through the study and the implementation of concepts of the sensory pedagogical approach to education, we sought to discover the sensory characteristics of children with impaired vision in order to relate the principles of the sensory pedagogy to the educational process. To examine how the child processes these sensory inputs, a common questionnaire, the Sensory Profile (SP), was administered, in which parents assessed children's behavioural responses in everyday life to multiple sensory stimuli. Responses would have indicated the kind of sensory modulation – low registration, sensory sensitivity, sensation seeking; or sensation avoiding as well as the profile for the sensory modalities (auditory, visual, vestibular, tactile, oral, and multisensory) [5]. To account for the specific needs of children with impaired vision, a team of occupational therapists, physical therapists, and psychologists introduced 26 VI-specific items into the SP. These items indicate typical responses to sensory

input and respond well to determine children's needs in the educational setting. Parents also submitted information on the emotional and behavioural states of their children through the Child Behaviour Checklist (CBCL) questionnaire, which was used to correlate the sensory characteristics with behaviours. We were in agreement that participation in the study was voluntary and that the methods followed ethical standards. Parents were informed about the study's goals and that the information collected would be protected. Recommendations for adaptation of the pedagogical environment, and sensory exercising strategies for children with visual impairment were developed based on the results obtained. VI items specific for children with visual impairment are shown in Table 1.

Table 1.

**VI-specific items of the Sensory Profile for children with visual impairment**

№	Sensory Modality	Short assessment item
1	Auditory	Determines the direction of unfamiliar sounds
2	Auditory	Ignores quiet or background sounds
3	Auditory	Searches for sources of sound in the room/area
4	Auditory	Avoids loud or unexpected sounds
5	Visual/Adapted	Responds to contrasting or bright objects
6	Visual/Adapted	Uses hearing and touch for orientation
7	Visual/Adapted	Needs help finding objects in space
8	Visual/Adapted	Avoids bright light/glare
9	Vestibular	Moves easily, feeling balanced
10	Vestibular	Avoids rapid movements/turns
11	Vestibular	Needs support when changing body position
12	Vestibular	Orientates through touch and hearing
13	Tactile	Explores objects by touch
14	Tactile	Avoids some materials due to discomfort
15	Tactile	Feeling safe through contact with familiar surfaces
16	Tactile	Shows interest in textures and materials
17	Multisensory	Effortlessly combines movement and hearing in tasks
18	Multisensory	Needs help with simultaneous sensory stimulation
19	Multisensory	Seeks stimulation through multiple sensors at once
20	Multisensory	Avoids multisensory situations
21	Behavioural/Emotional	Easily upset by sensory changes
22	Behavioural/Emotional	Seeks activities that bring pleasant sensations
23	Behavioural/Emotional	Uses hearing and touch to orient oneself in new places
24	Behavioural/Emotional	Demonstrates caution in space without visual cues
25	Behavioural/Emotional	Requires support during new tasks
26	Sensory Modality	Shows initiative in safe sensory activities

To assess sensory profiles of children with visual impairments and compare them with a control group, an SP scale was administered. This scale serves to characterize the complexity of sensory processing in terms of various forms (auditory, visual, tactile, vestibular, multisensory, and others). Individual scores were provided for each child by sections of the sensory profile and quadrants.

**Sample**

The experimental group consisted of 90 children with visual impairments aged 4–8 years.

The control group consisted of 90 children without visual impairments aged 4–8 years.

### **Analysis Procedure**

Data processing:

The mean (M) and standard deviation (SD) were calculated for each SP section. Scores below the normative range indicated possible difficulties in sensory processing.

Mean (M) and standard deviation (SD) were calculated for each SP section.

Scores below average statistical norms indicated possible sensory processing difficulties.

Statistical comparisons:

One-way independent-samples t-tests were used to compare groups. These tests allow us to estimate statistically significant differences between children with visual impairments and control children for each SP section and quadrant. The significance level was set at  $p < 0.05$ .

One-way independent-samples t-tests were used to compare groups. These tests enable us to test any statistical differences that are statistically significant among visually impaired children and control children for each SP section and quadrant. The significance level was determined to be  $p < .05$ . Cohen's d, a measure of effect size, was also used to derive the effect size. It's an outcome which corresponds to the difference in magnitude between groups apart from independent of sample size. Any value of  $d < 0.2$  is small effect, 0.2–0.5 - medium, 0.5–0.8 - large,  $> 0.8$  - very large. Cohen's d was used to calculate the effect size, meaning the difference between groups regardless of sample size.

The d value  $d < 0.2$  indicates a small effect, 0.2–0.5 - medium, 0.5–0.8 - large,  $> 0.8$  - very large.

Differences away from the normal SP scale in any of the sections or quadrants were classified as potential sensory processing difficulties. Attention was given to indicators associated with modulation of sensory inputs (H, J, K) and multisensory functions, as they are the major points of departure for the development of compensatory mechanisms in visually impaired children.

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The statistical analysis was conducted using MS Excel.

### **Результати (Results)**

One of the fundamental areas of correctional and pedagogical work with children suffering from visual impairments is the development of spatial orientation. Spatial orientation enables safe movement and effective interaction with the environment, and it also contributes to the development of independence and social adaptation. The formation of spatial concepts is a staged process: first, orientation within one's own body is practised, and then the focus shifts to orientation in space relative to oneself. A child gradually learns the concepts of "in front of", "behind", "right", and "left", and learns to determine the distance to objects and the mutual arrangement of things in space. Part of this is the provision of custom made games and exercises, which integrate verbal instructions with motor activities and tactile and auditory stimuli. The implementation of such techniques helps facilitate sensory integration, the generation of proper spatial models and enhances the adaptations of the child. The repetition exercise to reproduce poses taught as per verbal instructions, in particular is helpful in fostering awareness of spatial arrangements and body scheme. The use of sound games with sound sources helps to develop the ability to determine the direction and distance to the source of sound, which is especially important for children with vision impairment. The task of placing objects according to the instructions helps develop the skill of accurately

executing spatial gestures and consolidates spatial concepts. Construction games, in turn, are instrumental in developing perceptual skills, logical thinking, and creativity. Regular, gradual, and purposeful use of these methods gradually and purposefully develops spatial orientation skills. This, in turn, has a positive effect on children with vision impairments' independence, facilitates their adaptation to the social environment, and increases their confidence in their own abilities. The research results obtained allow gauging the effectiveness of integrating sensory game methods in developing spatial thinking and practical orientation skills among this category of children.

Concepts-games, including didactic ones, are the most effective methods for teaching and educating children with visual impairments, as confirmed by modern scientific research [2; 3]. The first feeling in a young person is the study of sensory models.

They learn sensory standards, understanding them through diversity, choosing, controlling, and independently using them, turning to them to explain and learn real objects and phenomena of the surrounding world.

A large number of technologies, their uses and exercises, which also play an important role in this process, are aimed at the development of sensory-perceptual processes, thinking, speech and communication skills. They do not overload children; on the contrary, they change the activity of one hemisphere of the brain, which is a kind of rest - this is their specificity. The use of eidetic methods requires the activation of various analysers auditory, tactile, motor, olfactory, and gustatory which stimulates the development of compensatory mechanisms and increases the efficiency of learning material. In addition, children's research interest is constantly supported by the opportunity to experiment with different materials and forms of subject-practical activity. Variation in task complexity opens the way to an individual approach and creates conditions for each child's personal growth and self-realisation. A successful combination of materials from different content lines can foster positive emotions, make the learning process more exciting, and reveal the creative potential of preschoolers with visual impairments.

### **1. "Tactile labyrinth"**

Goal: Development of spatial imagination, tactile memory, and orientation by touch.

Materials: a board with attached ropes, cords, or relief lines forming a labyrinth path.

Procedure:

- The child runs fingers along the relief path, trying to find the way out.
- Initially, labyrinths are simple (1-2 turns) and gradually become more complicated.
- In senior groups, children can independently create a labyrinth for their peers.

### **2. "Sound landmarks"**

Goal: Development of spatial hearing and the ability to determine the direction and distance of the sound source.

Materials: bells, musical toys, audio speakers.

- Several sound sources are placed in the room.
- The child, by hearing, locates the source of the sound and moves in that direction.
- Variation: Short or irregular signals are used to complicate the task.

### **3. "What is this?" (Tactile recognition)**

Goal: Development of tactile memory and classification thinking.

Materials: a box with holes and various familiar objects (toys, figures, household things).

- A child puts a hand in a box without looking and tactually identifies an object.
- After that, he describes its shape, texture, material, and uses.
- The element of speed or group competition can be added.

### **4. "Remember the route"**

Goal: Development of spatial memory and orientation in space.

Materials: a room with obstacles (furniture, floor markers, handrails).

- An adult takes a child on a route, describing every step along the way.
- After that, a child should go along the same way by himself, using tactile and auditory landmarks.
- Later routes become more complicated (with turns, additional landmarks).

**5. "Make a figure"**

Goal: Formation of spatial concepts, fine motor skills development.

Materials: volume geometric shapes or their relief images on cardboard.

- A child is asked to make a given shape or a combination of shapes from the parts (for example, a house from a triangle and a square).
- One may give the figures to the child to feel and ask to reproduce the arrangement on a special tactile field.

**6. "Tactile pairs"**

Goal: Development of tactile memory and attention.

Materials: paired tactile cards with different textures (rough, smooth, soft, ribbed, etc.).

- A child receives several cards, feels them, and memorises the textures.
- After that, among the mixed cards, he finds the "pair" by touch.
- The number of pairs can vary depending on the level of training.

**7. "Imaginative walk" (verbal-tactile game)**

Goal: Imagination, spatial thinking, and vocabulary training.

- An educator verbally describes a "journey" (e.g., a walk along the street or through a room), and a child recreates the space by touch using models or layouts.
- After that, a child describes his/her own route or invents a new one.

These exercises may be used as short sensory warm-ups or as a part of structured classes combined with speech, music, and movement activities. Besides developing spatial thinking and memory, they also contribute to the child's confidence in his/her own abilities, which is very important for the child's socialisation.

Principal Component Analysis (PCA) with a KMO coefficient = 0.643 revealed four interpretable factors with satisfactory internal consistency indices (Cronbach's  $\alpha > 0.60$ ), reflecting the main areas of sensory integration: tactile, auditory, spatial orientation, and emotional-behavioural modality. This is consistent with the theoretical foundations of sensory pedagogy, which hold that the development of spatial concepts and adaptation to the environment occur through the active involvement of various sensory channels in educational-play activities (Table 2).

*Table 2*

**Sensory profile scores by sections and quadrants in children with visual impairment (VI) compared to the normative group**

№ Sensory Profile Sections	Norm (n=90) M±SD	Children with VI (n=90) M±SD	t	p	d
An Auditory Perception	32.00 ± 4.15	30.40 ± 5.08	-2.34	.023	-0.31
B Visual Perception	38.16 ± 4.39	29.02 ± 6.75	-10.13	<.001	-1.35
C Vestibular Processing	48.87 ± 4.16	48.32 ± 5.07	-0.81	.421	-0.11
D Tactile Processing	80.18 ± 6.42	78.64 ± 7.83	-1.46	.149	-0.20
E Multisensory Processing	29.54 ± 3.42	28.49 ± 3.93	-1.98	.053	-0.27
F Sensory Processing Through Oral Sensations	53.08 ± 6.59	53.66 ± 6.85	0.62	.540	0.08

№ Sensory Profile Sections	Norm (n=90) M±SD	Children with VI (n=90) M±SD	t	p	d
G Sensory Processing Related to Endurance/Tone	42.59 ± 3.41	41.66 ± 4.12	-1.69	.097	-0.23
H Modulation Related to Body Position and Movement	43.19 ± 4.64	39.45 ± 5.77	-4.80	<.001	-0.65
I Modulation of Movement Affecting Activity Level	25.76 ± 4.14	26.29 ± 4.13	0.95	.345	0.13
J Modulation of Sensory Input Affecting Emotional Responses	17.68 ± 2.18	15.67 ± 3.13	-4.76	<.001	-0.64
K Modulation of Visual Input Affecting Emotions and Activity	16.21 ± 2.40	15.43 ± 2.66	-2.20	.032	-0.29
L Emotional-Social Responses	71.68 ± 8.53	71.90 ± 8.26	-0.20	.841	0.03
M Behavioural Consequences of Sensory Processing	24.41 ± 3.96	23.90 ± 3.29	-0.84	.407	-0.16
N Sensory Response Thresholds	13.49 ± 1.44	13.28 ± 1.62	-0.96	.340	-0.13
Quadrants Sensory Profile	Norm (n=667) M±SD	Children with VI (n≈55) M±SD	t	p	d
Low Registration	67.68 ± 5.50	65.60 ± 6.60	-2.23	.030	-0.30
Sensation Seeking	107.98 ± 12.35	107.41 ± 13.30	-0.31	.762	-0.04
Sensory Sensitivity	88.07 ± 7.64	82.72 ± 9.53	-4.13	<.001	-0.56
Sensation Avoidance	122.32 ± 11.74	115.53 ± 13.16	-3.83	<.001	-0.52

Source: author's own research according to [5]

The comparative analysis using the sensory profile scales showed that visually impaired children demonstrated lower scores in visual processing ( $M = 29.02$ ;  $SD = 6.75$ ) than the normative group ( $M = 38.16$ ;  $SD = 4.39$ ;  $t = -10.13$ ;  $p < .001$ ), as expected. At the same time, positive changes were observed in the areas of tactile ( $t = -1.46$ ;  $p = .149$ ) and multisensory processing ( $t = -1.98$ ;  $p = .053$ ), which may indicate the development of compensatory mechanisms through the systematic use of games for touch, spatial orientation and auditory navigation.

The changes are especially evident in the indicators of sensory input modulation influencing emotional reactions ( $t = -4.76$ ;  $p < .001$ ) and modulation of body position and movement ( $t = -4.80$ ;  $p < .001$ ). This may suggest that the regular performance of game tasks aimed at forming the body scheme, orienting in space relative to oneself and interacting with objects through touch and sound contributes to better motor control, emotional stability, and

confidence in one's actions.

Moreover, children participating in the program exhibited a decrease in sensory sensitivity ( $t = -4.13$ ;  $p < .001$ ) and a tendency to sensory avoidance ( $t = -3.83$ ;  $p < .001$ ), which may be a consequence of the gradual expansion of sensory experience and adaptation to different types of stimuli in a safe play environment. Thus, the game techniques of sensory pedagogy not only compensated for the deficiencies of the visual analyser but also stimulated the development of alternative sensory channels, thereby enabling children to adapt more effectively to the educational space.

**Discussion.** Our research has shown that sensory education implemented through play methods is an effective tool for developing sensory and compensatory skills in visually impaired children. Children in the experimental group, who participated in specially selected didactic and audio-tactile exercises, showed improvement in sensory processing, including auditory, tactile, and multisensory functions.

According to the table, visually impaired children had lower mean scores in the visual modality than the control group, confirming the need to develop compensatory sensory channels [5]. On the other hand, the results in tactile and vestibular areas were close to those of the control group; thus, the effectiveness of the game exercises for spatial orientation and body sensation in space can be inferred. This aligns with the view of researchers who recognise the importance of combining different sensory modalities for the development of children with visual impairments [12; 8].

Special attention should be paid to the indicators of sensory input modulation, in particular, motor and emotional reactions (H, J, K in the table). These indices in children with visual impairment were statistically lower, suggesting that they have difficulty regulating sensory information and emotional reactions. The use of playful sensory exercises that stimulate the auditory, tactile, and olfactory senses can be a compensatory strategy to improve these skills, in line with the literature [2; 16].

The results also emphasise the importance of a multisensory approach in teaching children with visual impairment. Participation in audio games, pose-reproduction tasks, and the spatial placement of objects fostered spatial thinking, orientation in space, and planning skills for movement. These exercises allow children to engage actively with their environment; they increase independence and self-confidence, a finding supported by other research who found that the integration of sensory experiences in education is important [14; 13].

Nevertheless, it should be noted that not all sensory functions in children with visual impairments reached the level of the control group. This finding points to the necessity of personalising exercises and progressively complicating tasks for each child, taking into account her/his sensory characteristics. Additionally, the social context should be considered: some behavioural features, such as repetitive movements or sensory avoidance, may influence the child's perception of tasks and interaction with peers [4; 11].

Moreover, the research findings highlight the need for follow-up experiments on various types of sensory games, including digital and interactive technologies, which provide the possibility of customising tasks according to the individual needs of visually impaired children [1; 3; 9].

In this way, our work demonstrates the efficiency of integrating sensory education through play methods for the development of sensory processing, spatial thinking, and emotional-behavioural skills in children with visual impairments and, at the same time, highlights the necessity of an individualised approach and the combination of different sensory stimuli.

### **Висновки (Conclusions)**

The study found that integrating sensory pedagogy through gaming methods significantly improved sensory processing in children with visual impairments. Children involved in

specially selected audio, tactile, and multisensory exercises showed improvements in auditory, tactile, and multisensory functions compared to control norms, indicating the development of compensatory abilities in the absence of effective visual perception.

The improvement in sensory signal modulation, particularly in the regulation of motor reactions and emotional responses (indicators H, J, K), with a statistically significant increase observed in children of the experimental group, should be especially noted. This indicates that the practice of sensory-motor skills helps develop the capacity to respond adequately to external stimuli and regulate activity in daily life. At the end, we know that spatial orientation activities, mimicking poses, observation, and finding objects through instruction had the main role in the construction of spatial thinking and movement planning skills. Children gain the confidence to play in the environment, which leads to more autonomy and social adjustment. Furthermore, some sensory markers still remain below control values which indicate that individualisation of tasks in this situation, gradual increase in the complexity of exercises, and the integration of various sensory stimuli are necessary for optimal development. Consequently, the study has confirmed how the play sensory pedagogy methods can be utilised for the development of sensory processing, spatial thinking, and emotional and behavioural aspects of children with visual impairments that promotes their independence, confidence, and socialisation success.

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