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The use of the C-eye system in communication and education of children

Abstract: Marta Zawichrowska, *The use of the C-eye system in communication and education of children*. Interdisciplinary Contexts of Special Pedagogy, No. 33, Poznań 2021. Pp. 81–91. Adam Mickiewicz University Press. ISSN 2300-391X. eISSN 2658--283X. DOI: https://doi.org./10.14746/ikps.2021.33.06

During working with children with communication disorders, they are more and more often accompanied by devices supporting the development of speech. One of them is the C-eye system, which is used especially in two areas – communication and education. This article is an introductory report on the research on the use of high technologies in working with children with developmental disorders, accompanied by deficits in the field of verbal speech. The described case study concerns a child with delayed speech development, without any additional health burden, in whom the etiology of communication disorders has not been determined despite careful diagnostics and many specialist consultations. The article was written on the basis of observations, an interview with the family and the recommendations provided, and presents the original path of therapeutic treatment with the use of the C-eye device, which can be used in work with preschool and early school children. Very important was the neurologopedic diagnosis and research conducted during the therapy, which allowed for the proper definition of therapeutic goals and showed its effectiveness, both in the communication, educational and social sphere.

Keywords: child, speech, delayed speech development, C-eye system, communication, education

Education and therapy of the 21ˢᵗ century is a challenge for teachers, therapists, children and parents, among other factors due to the

increasing use of multimedia tools, new forms of online work or modern devices facilitating mutual communication and learning.

> Using them to provide therapeutic services also enables a high degree of standardization of therapy, which makes it easier to interpret individual factors that may affect changes in behaviour (Pąchalska, 2014: 246).

The use of technology applies to ordinary schools as well as schools for children with special needs; children within the developmental standard as well as children with problems in verbal communication with the environment.

> The computer provides new possibilities for speech therapists, allows to intensify certain stages of work, it makes it easier and more attractive. (…) It can be used at all stages of therapeutic work (at the preparatory, proper and consolidating stage), during the therapy of various speech and language disorders, e.g. delayed speech development (Walencik-Topiłko, 2005: 1019–1027).

The more and more frequent presence of modern technologies in communication and education of children with dysfunctions, and their use by therapists and teachers, contributed to the writing of this article, which would be a proposal to use the C-eye system in education and communication.

This article is about a case study of a preschool boy, Adam, who does not communicate verbally due to delayed speech development. The boy started speech therapy at the age of 4 (in the kindergarten), and has been using the C-eye system for 2 years. From September, he is to go to a special school, where the purchase of the C-eye device is planned.

According to the authors of the methodological guide

> (…) the C-eye system is a fully integrated system enabling the neurorehabilitation of people with neurological dysfunctions as well as supporting alternative audio-visual communication with the use of eye tracking technology (Kwiatkowska, Kunka, 2016: 7).

The anatomical structures required to work on the C-eye include: the eyeball, the oculomotor muscles, the optic tract and the cortical areas of visual analysis (fields acc. to Brodmana 17, 18, 19) (Kochanowicz, 2016: 75).

It can therefore be concluded that apart from the ability to see (with at least one eye), the element necessary to work with the device is at least the minimum ability to maintain attention and focus on the screen under which the eye tracker is located. Thanks to establishing human-interface contact, the user

> (…) establishes eye contact with the displayed content, i.e. graphics, photos, words (Kwiatkowska, Kunka, 2016: 7).

A few years ago, the C-eye system was equipped with an additional module called *Eyefeel*, addressed to people with communication barriers. Due to its interactive nature, it is most often used by children to practice their eyesight, develop memory, thinking and communicating their needs. It is worth emphasizing that the device is extremely intuitive – it is very easy to adjust its parameters (volume, margin, selection time, cursor size, etc.) to the user's limitations. It provides a wide range of tasks supporting development of skills and shaping new skills. It is also an inestimable support in communicating the needs of its users. One of them is the above mentioned Adam.

The boy's medical records show that he is a child with no perinatal complications. Consultation with a rehabilitation doctor and a physiotherapist showed that the boy's motor development is normal. The family is undergoing genetic diagnostics. Adam has 3 siblings (2 brothers and a sister) with no verbal abnormalities. Laryngological and audiological causes of the lack of speech development were also excluded. The boy's EEG examination performed several times also showed no abnormalities. Magnetic resonance imaging showed no changes in the central nervous system (CNS). The boy's neurological opinion describes the etiology of delayed speech development as unexplained.

Based on an interview with his parents, it is known that Adam was babbling, but his speech stopped developing and he was not making progress. The boy's mother's account shows that the older the boy is, the more he is aware of his communication difficulties and it becomes more and more difficult for him to disguise his deficits. It happens that the fact of being misunderstood by the environment causes him to become frustrated and cry, which causes difficulties in relations with siblings and peers. The lack of progress in the development of verbal speech, educational difficulties and the initiation of preschool education prompted the family to conduct a speech therapy diagnosis, which showed speech development delay. The contemporary assessment of colours thus determined the boy's functioning at the level of a minor intellectual disability and described the child's development as inconsistent. The child was also diagnosed with astigmatism and was advised to wear glasses.

When Adam started working on the C-eye, his communication disorders concerned both active and passive speech – during the first meeting he made no attempts to communicate at all. During the following attempts, he could indistinctly repeat only a few short words (including his name), and the eye contact made was very brief. The abnormalities also concerned respiratory and phonation coordination. The boy expended the air from his lungs uneconomically and was unable to synchronize his breathing pauses with his attempts to transmit messages. This resulted in difficulties in dynamic breathing, which is characterized by a short breath taken through the mouth and a long exhalation during which the message is transmitted through speech. In Adam, phonation dysfunctions could also be observed – very often the child's voice was squeaky, resembling a scream. This was caused by an improper vocal adjustment ("glottal attack") – hard glottal attack, during which

> (…) there is a sudden closing of the vocal ligaments. This type of phonation uses a relatively large amount of air, which, flowing in a dynamic, sharp stream, destroys the voice organ (Minczakiewicz, 1997: 38).

The diagnostic test also revealed that Adam did not know the graphic notation of vowels – he was unable to name any of them, nor to point them at the therapist's request. There were also difficulties with naming and indicating shapes, animals and onomatopoeic words. Similar problems concerned colours – Adam named some of them but in English, not in Polish, e.g. red, blue. It was also troublesome for the boy to point out the differences between two pictures and to count on his fingers how old he is. It is these areas (breathing and phonation), along with the development of verbal communication, that are common points of speech therapy in the kindergarten and outside it. The first assessment of the patient on the C-eye device revealed problems with the concentration of visual attention and with the eye's fixation movements (The fixation movement is the ability to keep the eyesight on the presented visual stimulus). Difficulties with visual analysis and synthesis were also apparent. The range of vision was also limited, especially on the left side.

Due to the abnormalities identified during the first meeting, initially most of the work time with the C-eye system was devoted to improving the oculomotor muscles and extending the time of eye concentration on the presented object.

The first meeting was to familiarize the child and parents with the device, to show its applicability and to support Adam in the development of verbal speech. Adam's contact with the C-eye system began with the visual range exercises – due to its narrowing on the left side. From the very beginning, the trumpet attracted the child's special attention from the very beginning. Following him with his eyes and focusing his eyes on him, Adam heard the sound, and during the third meeting he began to imitate it (tu-tu-tu). During the first several therapeutic meetings, the work on the C-eye device also included Adam's family photos, which were displayed on the screen – viewing, pointing to them and describing them gave the child a lot of joy. They contained elements of space, objects, animals and people known and close to the child, which overcame his shyness to speak and distracted him from possible skirmishes. As a result of several meetings, an individual presentation was created on the C-eye device – an album of

photos. We used them to train attention and eyesight concentration, which are necessary for working with the C-eye system, and which caused Adaś a lot of problems at the same time.

The next step while working on the device, when Adam's visual attention was improved, was the introduction of Eyefeel and interactive animations, which, as recommended by the manufacturer

(…) serve therapeutic and educational purposes (Kunka, 2017: 14).

For this purpose, we used, among others, coloured boards. We started learning colours with two: green and red (we named each colour in Polish), which, due to its saturation, more often attracts the attention of device users. Adam's task was to fix his eyesight on the green field – then the computer began to count how long the child looks at a specific area and saturate the field with colour more and more. Adam was by far the most fascinated with this task, teaching him to count at the same time.

Consolidating the learning to count and distinguishing colours with the use of the C-eye system is possible by introducing the child to the educational animation module. It was the next step in working with Adam. An example of colour exercises that simultaneously develop the child's activity in nature may be, for example, consolidating colours while preparing a virtual salad of vegetables or fruit (thanks to which the child's vocabulary is also enriched), or selecting colours in the Colouring Book task, which is an activity necessary to fill the elements of a picture with different colours. Practicing the child's mathematical activity is possible in the Crayons exercise, which consists in sorting the crayons – the therapist can choose a characteristic feature (length, colour, thickness). The child's task is to line up the crayons and put them in the box, fixing his eyesight on each of them. An additional advantage of the exercise is the development of categorization skills,

(…) distinguishing spatial relations, distinguishing qualitative and quantitative features of a set of elements, counting the number of crayons and comparing the number of sets (Kunka, 2017: 24).

Each of these skills is extremely important in a child's early education and school learning.

As one of the main goals of working with Adam was to exercise attention and concentration as well as visual and auditory coordination, another element of the therapy was practicing nature activity (initially at the basic level). It should be emphasized that each of the exercises proposed by the C-eye system contains a gradation of difficulties, which is an undoubted advantage and is also used in school learning.

An additional difficulty was the deficiencies in naming and imitating animals, which were revealed by the diagnosis. In the Farm task, the goal is to take all the animals on the farm (chicken, cow, horse, dog) to their homes. The task turned out to be difficult for Adam due to his eyesight problems. He worked very well with large animals (cow and horse) whereas the small figures of a dog and a chicken caused him difficulties. The dynamics of the C-eye device's functions and the possibility of zooming the image was very helpful. Thanks to this, Adam was able to complete the training of visual functions. The task described above

> (…) has many therapeutic and revalidation possibilities, which include: practicing visual functions on picture material, practicing spatial orientation as well as visual analysis and memory, acquiring the ability to recognize the relative position of objects in space, comparing objects by type as well as giving names and recounting sets (Kunka, 2017: 23–24).

The educational value related to the above exercise allowed Adam to assimilate, and then imitate the sounds made by animals, and gain knowledge about their needs and functioning in the world.

Due to the persistent problems with the visual range and focusing visual attention on small objects, the next activity in working with the C-eye system was the kinesiological eight. Adam knew the exercise but the computer eye tracking version made him curious. From the educational and therapeutic point of view, thanks to the support of the eye tracker, the therapist is able to track the child's eye movements,

which is not possible in traditional therapy. After adjusting the board and objects to the boy's possibilities and limitations, Adam moved a blue triangle of his choice (also a circle, square and an asterisk can be selected) along the eight-shaped track and he successfully completed the exercise. Exercising with the use of the C-eye system also turned out to be an inspiration for the training of breathing and phonation – as long as Adam followed the track, he was phoning certain sounds [a, e, i, o, u]. Thanks to this, he learned the next vowels, thus extending the expiratory phase. In addition, by means of non-verbal communication, but also more and more often verbally, he repeatedly tried to tell me that he was watching Formula 1 with his dad and that the eight reminded him of a car track. In this way, the exercises were not limited only to eye movements, but also short-term and long-term memory, aided the thinking process and prompted Adam to formulate thoughts and to convey them verbally.

After 2 years of therapy with the use of the C-eye system, the boy continues to develop active speech: he correctly recognizes and names vowels, repeats syllables and short words he has written on the screen. However, he still has difficulty repeating 3 or more syllable words. This is due to the persistent issues of articulation kinesthesia – Adaś does not always remember the correct positioning pattern of the articulation organs, necessary to utter a specific sound. The efficiency of the articulators is significantly reduced. Therefore, each class begins with a speech therapy massage, which is a compilation of various techniques of palpation acting on the orofacial sphere aimed at activating and increasing awareness in the orofacial area and preparing the articulation organs for speech. Because

> (…) the patient's rehabilitation requires the application of basic principles that take into account the specificity of the disease and their dysfunctions, especially in the cognitive, emotional, motivational and social spheres (Regner, 2019: 9).

It is significant that with age Adam himself more and more often notices that his speech and voice are different from his peers. It should be noted that during the two years of speech therapy, the

quality of breathing and phonation improved; however, occasionally the difficulties reappear (especially in emotional moments). Nevertheless, the communication intention was maintained in the child all the time. It is also due to the C-eye system, and more precisely the communication module, which allowed Adam to communicate his needs and requests. Initially, Adam's work on communication was based on black and white pictograms – due to the lack of knowledge of the letters. They showed emotions, moods, but also presented food products, animals and activities. Each of the pictograms was first called by the therapist, and then viewed (with the eyes) by the child, pointed (with the square) and named (with words) by the child. Thanks to this, hand-eye activity and work on verbal communication were trained. With time, movement was also included in the exercises, i.e. while dividing the words into syllables, the child tapped the rhythm against the knee. Currently, Adam begins to learn letters on the device using, among other things, a virtual keyboard, with the help of which he constructs the first syllables and short words, which he then repeats. When conducting a dialogue, he often uses ready-made boards and Yes-No buttons with a colour and a thumb up-thumb down gesture.

Currently, work with the use of the C-eye system focuses on the use of the Neurorehabilitation module, in particular the development of linguistic functions and Adam's verbal activity. The most common way to do this is to understand the words read by the device, select the appropriate picture for them and then repeat. Similarly, when it comes to sound – Adam identifies the sound he heard, tries to repeat it and choose it to match the picture presented on the screen. The recognition and repetition of onomatopoeic words has improved – Adam distinguishes between the instruments and animals presented on the screen and is able to imitate them. The level of difficulty in counting and learning colours is also increasing all the time – now Adam can distinguish 6 colours, he can indicate and name them. In terms of counting, the child can count up to 10, however he does not know what number follows the previous one, when it is taken out of context and devoid of automatism. Recently,

training on the device has been extended to exercises of visual and spatial functions (based on the perception of objects, sizes, shapes, objects) and memory exercises. The stories that Adam wrote in the task of developing cause-and-effect thinking turn out to be the most interesting. Because the Patient's attitude to working with the C-eye device is extremely important, each meeting ends with a therapeutic game that not only consolidates the previously acquired skills, but also teaches logical thinking. The virtual tic-tac-toe game is very popular, and so is the game of discovering puzzles with the eyes – additionally, it is a pretext for the development of a dictionary of active speech and repetition of already known words.

Thanks to the possibilities of the device, modifications are made all the time to set parameters, which must be adapted to both the possibilities and limitations of the child. The user's field of view was initially narrowed on the left, which meant that most of the content was presented on the right. However, it was widened over time. Currently, Adam is working the entire width of the screen. The time of the eyes fixation was also adjusted to the child's abilities – this procedure was aimed at performing the entrusted task and arousing the child's sense of agency and increasing motivation to work. Initially, it was 1.2 seconds, and now it is 1.6 seconds and is constantly being extended.

Adam's motivation can be assessed at a very high level – he willingly comes to therapeutic classes, he is very active during them, he is open to learning about new tasks and increasing their level. It also happens more and more often that Adaś begins to initiate actions on his own – he does it both verbally, making attempts to speak and supporting himself with non-verbal communication (mimics, gestures) which

(…) constitute as much as 55% of the information message (Kowalczyk, 2020).

Adam's teachers indicate that the boy's abstract thinking ability, ability to express needs and his responses to the situation have

improved. Functioning in the group, the tutors point out that Adam initiates peer contacts more often and more willingly. Their observations show that the boy is able to verbally express his basic requests and needs, which are understood by both children and kindergarten staff.

Summing up, it can be concluded that the key to communication progress is the child's sense of agency and the feeling of being understood better. An important issue that translates into the therapeutic success of the patient is also the cooperation of specialists, in this case a speech therapist from a kindergarten and a therapist working with the child outside of the kindergarten. Agreeing on common goals of therapy and a mutually complementary work plan gives the opportunity to provide real help, noticeable by the environment, but most of all perceptible by the patient. The support of doctors, physiotherapists and other specialists supporting the child in its development is also important. As the example described above shows, not only does the introduction of modern technologies to speech therapy broaden the child's interests, increase the attractiveness of the classes and results of education, but it also translates into tangible achievements of the child in the sphere of verbal communication, and thus its better social functioning.

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