The Warnke method as a support in education of children with mild intellectual disabilities

Ewa Brzdęk

Abstract—Intellectual Disability may be a serious obstacle for some persons in the process of learning. Similar problems can be caused by Auditory Processing Disorders. On the other hand, the Warnke method seems to be a very effective supporting tool in the process of education of children with such intellectual disabilities of mild degree. We discuss shortly all those issues in this article.

***Keywords*—**Intellectual disability, auditory processing disorder, education, technology, Warnke method.

I. Introduction

One of the main obstacles in the process of education may be the intellectual disability, which cause a child to intellectually develop and acquire knowledge more slowly than other children. The term intellectual disability refers to a condition in which a person has certain limitations in the following three areas:

- intellectual functions like communicating;
- taking care of him- or herself;
- social skills.

Children with such difficulties do learn, but generally it takes them more time than those unimpaired: they take longer to walk, talk, and take care of themselves. Moreover, very likely certain things will be impossible for some of them to acquire.

Some educational problems also may be a result of some disorders in central auditory processing (CAP), which means the perceptual processing of auditory information in the central auditory nervous system (CANS) and the neurobiological activity that underlies that processing and gives rise to electrophysiologic auditory potentials (American Speech-Language-Hearing Association [4], 2005). Such disorders are usually called (Central) Auditory Processing Disorders (APD or CAPD) [2].

In the further parts of this paper we discuss shortly those two educational obstacles and next present the Warnke method which seems to be a promising supporting tool in such difficult situations.

II. Intellectual Disability

The intellectual disability may impair adaptive functioning in the conceptual, social and/or practical areas. The first domain means skills in language, reading, writing, mathematics, reasoning, knowledge, and memory. The social domain refers to empathy, social judgment, interpersonal communication skills, the capacity to make and retain friendships, and similar abilities. Finally, the practical domain concerns self-management in personal care, job responsibilities, money management, recreation, and organizing school and work tasks.

The fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5) of American Psychiatric Association, published in 2013 by American Psychiatric Association Publishing, introduces the diagnosis of intellectual disability (intellectual developmental disorder) to replace the DSM-4 diagnosis of mental retardation. The main changes concern the name of the disorder, its impact on a person's functioning, and criteria improvements to allow more comprehensive patient assessment. This means in particular a move away from a multiaxial approach to evaluating conditions. "Using DSM-IV, mental retardation was on Axis II to ensure that clinicians identified associated impairments alongside other mental disorders. With DSM-5, all mental disorders will be considered on a single axis and given equal weight" [3].

The intellectual disability may occur in any age, but an individual's symptoms begin in the developmental period and can be diagnosed from the deficits in adaptive functioning. Such disorder is in general chronic and may co-occur with depression, ADHD, and some kind of autism.

Intellectual disability affects approximately 2-3% of population, of which 75-90 % have a mild form. It can be subdivided into syndromic intellectual disability and non-syndromic intellectual disability. In the syndromic disability the intellectual deficits are associated with other medical and behavioral signs and symptoms, for instance Down syndrome and fragile X syndrome. Around 25 % of syndromic cases are caused by a genetic disorder. In non-syndromic disability, which occurs in 30-50 % of cases of intellectual disability, the intellectual deficits appear without other abnormalities.

Intellectual disability has four degrees of severity, depending on the level of the impairment (IQ):

- mild, when the IQ level is 50-55 to approximately 70;
- moderate, when the level of IQ is 35-40 to 50-55;
- severe, when the level of IQ is 20-25 to 35-40;
- profound, when the level of IQ is below 20 or 25.

If a child does not attend a school yet, some delays can be already noticed in speech or fine motor skills (such as

Author is with the Department of Special Pedagogy, Pedagogical University of Cracow, Kraków, Poland (phone: +48-12-3583923; e-mail: ebrzdek@ wp.pl).

crawling, walking, running, using eating utensils) and they may look different from one child to another. But the main intellectual disability types are usually formed according to the school-area skill sets, which are mainly reading, writing, and mathematics.

Disability in reading: There are two types of intellectual disability in reading. The first one can be characterized by issues in understanding relationships between letters, sounds, and words, while the other means problems with reading comprehension and a child has difficulties in grasping the meaning of words, sentences, and paragraphs. We can observe the following issues in the intellectual disability in reading:

- poor letter and word recognition;
- poor understanding of words and ideas;
- slow reading speed and low fluency;
- poor vocabulary skills.

Disability in math: The math difficulties may be a result of some other language disability, visual impairment, problems with memorizing and organizing numbers and facts, sequencing, as well as with telling time and with understanding the abstract ideas. Therefore, this intellectual disability vary widely depending on a child.

Disability in writing: Intellectual disability in writing may concern either of the following activities (also both):

- physical activity of writing;
- the mental activity of comprehending information and putting it together.

Such disability means problems in forming letters, words, and written expressions, which can be recognized by any of the subsequent issues:

- messy writing;
- problems with accuracy in copying letters and words;
- spelling problems;
- problems in writing with coherence and organization.

Disability with motor skills: The motor skills disability means problems with both gross and fine motor skills. Children with such disability may seem uncoordinated for their age and have significant problems with movements, especially those that require hand to eye coordination.

Disabilities with auditory and visual processing: Some learning difficulties can be a result of auditory or visual processing problems, i.e., problems in processing the things that can be heard and seen. It may be a lack of the ability to tell the difference between some sounds or to distinguish the difference between some shapes and images.

ADHD and autism: Attention deficit hyperactivity disorder (ADHD) and autism are examples of other disorders that may occur along with intellectual disabilities. The degree of learning disabilities depend on the severity of such impairments.

Disability with language: Language intellectual disability means impairments in the ability to speak and to understand spoken words, which may include the following issues:

- difficulties in understanding speech parts;
- speech fluency problems;
- problems in retelling a story;
- problems with understanding meanings of word;
- difficulties in carrying out instructions.

III. Intellectual disability with language

Children with intellectual disability with language can be compared to normally developing children with respect to their language development, divided into several major aspects. Below, we shortly discuss some detail of those aspects, because language skills are very important in all areas of education.

One possible division distinguishes the received and expressed language, while another identifies language systems such as phonology (sound system of language), syntax (rules used to put words together into sentences), morphology (the use of grammatical markers that indicate number, tense, gender etc), semantics (meaning of words and word combinations) and pragmatics (the way in which language is used in social situations).

In phonology, receptive is: hearing and discrimination of sounds in language; expressive is speaking and production of sounds of language. In syntax, receptive is comprehending how structure of language or order of words affect meaning, while expressive is producing language with structure that communicates meaning. In morphology, receptive is comprehending meaning units and expressive is producing meaning units. In semantics, receptive is comprehending word meanings (vocabulary) and expressive: producing language using words meaning (vocabulary). In pragmatics, receptive is comprehending language in light of its social context and expressive is producing language suitable to the social context.

Children also must learn how to use language in social contexts. Participants of a usual conversation should be able to stay on the same topic for some time, formulate their messages in a clear way, take turns, and follow the cultural rules of interactions.

In normally developing children various studies have shown that the ability to take turns in conversations does not show any developmental change with increasing language abilities [5]. From the beginning children know that they should respond verbally to their mothers' utterances. Furthermore, their conversation becomes more advanced with increases in their linguistic capacity. They are able to maintain a topic of conversation over increasing number of turns [5]. Certainly, this is not that easy with some children having certain types of intellectual disability with language [1].

Shortly speaking, children with language intellectual disability show retardation in the following areas of development: prelingual, vocal, social-communicative, semantic, phonological and early grammar. They acquire syntactic and morphological knowledge in the same way and in the same order as the normally developing children, but apart from the early stages, significant differences can be visible later. For example, children with Williams syndrome acquire mature grammatical system, whereas children with Down syndrome show serious limitations in the grammatical development. This deficit in children with Down syndrome may be due to specific impairment to the mechanism that serves to process linguistic information [10].

So, finally we can conclude that children with intellectual disabilities are able to acquire basic pragmatic language skill, but at advanced levels they face difficulties that go beyond their cognitive and linguistic levels [1], [14], [16].

IV. Auditory processing disorder

The term auditory processing disorder (APD) concerns various disorders that affect the way in which the brain processes auditory information. It is also known as central auditory processing disorder (CAPD); for instance ASHA (American Speech-Language-Hearing Association) uses that term to refer to some deficits in the neural processing of auditory information.

The following working definition has been proposed by the Committee of UK Medical Professionals Steering the UK Auditory Processing Disorder Research Program: *APD results from impaired neural function and is characterized by poor recognition, discrimination, separation, grouping, localization, or ordering of speech sounds. It does not solely result from a deficit in general attention, language or other cognitive processes.*

Persons with APD cannot process the information they hear, as most of people do, even if they usually have normal structure and function of the outer, middle and inner ear (peripheral hearing). This leads to certain difficulties in recognizing and interpreting sounds, especially those of which the speech is composed. It seems that these difficulties can be a result of a dysfunction in the central nervous system and may be connected to the issues with

- auditory performance in competing acoustic signals (e.g., selective attention);
- sound localization and lateralization (which may result in problems determining the direction of sounds);
- auditory performance with degraded acoustic signals;
- auditory discrimination and auditory pattern recognition (resulting, e.g., in confusing similar sounds such as "hat" with "bat", "there" with "where", etc);
- temporal aspects of audition, including temporal integration, temporal discrimination (e.g., temporal gap detection), temporal ordering, and temporal masking (occurring when a sudden sound makes inaudible other sounds that are following or preceding it immediately) [15].

APD affects both children and adults and can be developmental or acquired, e.g., from ear infections, head injuries or neurodevelopmental delays (affecting processing of auditory information). Children with Auditory Processing Disorder often:

- have problems to pay attention to and remember information that is presented orally (they may cope better with visual information);
- have difficulties to carry out multi-step oral directions (prefer only one direction at a time);
- have poor listening skills and need more time to process the acquired information;
- have behavior problems;
- have language difficulties (e.g., they confuse syllable sequences and have problems developing vocabulary and understanding language);
- have difficulty with reading, comprehension, spelling, and vocabulary;
- usually presents low academic performance.

It is well known that, generally, people with auditory processing disorder may subconsciously support themselves with visual strategies (lip reading, reading body language, eye contact) to compensate for their auditory deficit, and such strategies are not available when using some modern communication means. Therefore using, for instance, a telephone can be problematic for someone with auditory processing disorder, in comparison with someone with normal auditory processing, due to low quality audio, poor signal, intermittent sounds and the chopping of words [7].

There are numerous publications concerning the treatment of APD. For example, the American Speech-Language-Hearing Association (ASHA) published "(Central) Auditory Processing Disorders" in January 2005 as an update to [8]. The American Academy of Audiology has released more current practice guidelines related to the disorder. In 2011, the British Society of Audiology published the *best practice guideline*s.

Finally, we also should mention that some overlap has been noticed between clinical profiles of children diagnosed having APD and those with other specific learning disabilities. Therefore some pathologists of speech-language [11] and psychologists [13] question the status of APD as a distinct disorder. But, on the other hand, some audiologists disagree that APD is just an alternative label for dyslexia, SLI, or ADHD, because although it often co-occurs with these conditions, it can also be found in isolation [9].

V. Warnke method

The human brain has an ability to change (plasticity) to a certain degree. It is most plastic in childhood, but also in adulthood it shows much of it. Therefore, if some learning deficits are related to brain functioning, it is reasonable to expect that they can be changed, at least to some extent.

Fred Warnke, a communication-expert, developed a method allowing to identify and train some intellectual deficits. The method checks and trains suitable brain functions quickly and in a playful atmosphere, while testing the central processing of perceptions. It measures to what extent the functions are automated and compares the results obtained against standardized data of other children. In this way we can find out if there are deviations or even clear malfunctions [12].

The Warnke method is based on the three foundation stones, which are

- automation of the processing of perceptions in hearing and seeing and motor skills;
- automation of the coordination of the brain-hemispheres;
- development and automation of a visual dictionary.

One can improve such skills as reading, writing and calculating, using devices called: Brain-Boy Universal Professional, Brain-Boy Universal, Audio-Video-Trainer, and

Lateral-Trainer Professional. Children playing special games on the first two devices improve seven basic functions. Moreover, Audio-Video-Trainer and Lateral-Trainer Professional can be used to coordinate hemispheres and stimulate central processing of perceptions, which may help in general prevention against dyslexia and dyscalculia. One of the most important parts of the method are tests, validated by a large number of qualified experts. For more details and further references see [6].

The following 14 steps form the testing procedure (lasting for around one hour): 1. Visual Order Threshold; 2. Auditory Order Threshold; 3. Spatial Hearing; 4. Pitch Discrimination; 5. Auditory Motor Coordination (Finger-Tapping); 6. Choice-Reaction Time; 7. Frequency Pattern Test and Duration Pattern Test; 8. Coordinative Skills; 9. Reading Meaningless Texts; 10. Short Time Memory; 11. Perception Discrimination; 12. Dynamic Vision; 13. Angular Ametropia; 14. Visual Spelling (for more details and a description of those steps we refer to [6]).

In particular, with the device Brain-Boy Universal Professiona we can test and train the following eight low-level functions: visual order threshold, auditory order threshold, spatial hearing, pitch discrimination, auditory motor-timing, choice reaction time, frequency pattern recognition, duration of tones recognition.

A research carried out at the Medical University of Hanover proved the efficiency of those functions training. There are different percentile rank lists (available for children between 5 and 12 years) for each of the eight functions, developed during a standardization project carried in cooperation with the Medical University of Hanover. The references values are those that were obtained by 50 % tested children from each of age groups; target values are those that were achieved by 80 % tested children [17].

VI. Examplary reasearch results

The researches was carried in Departament of Special Pedagogy in Pedagogy University of Cracow (Krakow, Poland) and concerned the effectiveness of the Warnke method in testing and training the eight low - level function in the following group children:

- an 8 years old boy with mild intellectual disabilities and speech disorder problems;
- a 13 years old boy with mild intellectual disabilities, FAS (fetal alcohol syndrome) and short-time verbal memory (phonological memory) problems;
- a 7 years old bilingual girl with difficulties in reading and writing;
- an 8 years old girl of normal IQ, but with initial dyslexia problems.

Below, in two tables, we only present results concerning the boys.

The object of research in the case of 8 years old boy (boy nr 1) was the effectiveness of Warnke Method in improving and developing the speech abilities. During the pre-test we focused on the diagnosis of the level of language and communication skills and the level of eight basic functions of central auditory, visual, motor processes. We applied the following tools: Language Skills Test by Z. Tarkowski (Polish linguistic tests, Lublin 2001) and functional test by electronic device Brain Boy Universal Professional (BBUP). The training of the auditory, visual, motor central functions was conducted for five months, with twenty meetings every week, and the length of time each session of about forty five minutes. The procedure of post-test was the same as in the pre-test. We checked the same communication and central functions skills, and used the same tests and the BBUP device.

The results of boy nr 1 are following:

Function	A	B	C	D
1. Visual order thereshold	47 ms	24 ms	240 ms	80 ms
2. Auditory order thereshold	99 ms	49 ms	550 ms	80 ms
3. Spatial hearing	74 μs	42 μs	600 μs	100 μs
4. Pitch discrimination	24 %	8 %	68 %	14 %
5. Auditory – motor coordination	403 ms	322 ms	830 ms	692 ms
6. Choise reaction time	1042 ms	616 ms	1040 ms	488 ms
7. Frequency pattern test, recognizing low-high tones	200 ms	90 ms	800 ms	200 ms
8. Duration pattern test, recognizing short-long tones	200 ms	127 ms	500 ms	140 ms

Description of columns:

A - Reference value for age 8 years;
B - Target value for age 8 years;
C - Initial diagnosis values;
D - Final assessment values.

After the training and after the second diagnosis of language and communication skills, we confirmed the progress in the development of speech. We observed:

- progress in articulation of sounds and words, no metathesis, smaller number of substitutions and devocalizations;
- improvement of understanding of words, tags, questions, commands, longer utterances;
- improvement in usage of syntactical rules;
- extended words collection and wider semantic scope;
- improvement in creation of tags, questions and longer text.

The main goal of the training with the 13 years old boy (boy nr 2) was the effectiveness of Warnke Method in the improvement of phonological memory. During the preliminary test we focused on the diagnosis of the receptiveness of phonological memory and on the level of eight basic functions of central auditory, visual and motor processes. The following tools were applied: modified Memory Test of Rey and functional test by the device Brain Boy Universal Professional (BBUP). The training of the auditory, visual and motor central functions was conducted for five months, with twenty meetings every week. The length of each session was around

forty five minutes. During the post-test procedure we checked the same memory functions, using the same tests and the BBUP device.

The results of boy nr 2 are following (the description of columns is the same as before):

Function	A	B	C	D
1. Visual order thereshold	35 ms	20 ms	120 ms	28 ms
2. Auditory order thereshold	65 ms	42 ms	50 ms	55 ms
3. Spatial hearing	39 μs	22 μs	20 μs	18 μs
4. Pitch discrimination	21 %	6 %	1 %	1 %
5. Auditory – motor coordination	292 ms	223 ms	315 ms	321 ms
6. Choice reaction time	648 ms	324 ms	466 ms	557 ms
7. Frequency pattern test, recognizing low-high tones	116 ms	30 ms	180 ms	46 ms
8. Duration pattern test, recognizing short-long tones	107 ms	53 ms	110 ms	100 ms

Boy nr 2 - the test of the phonological memory capacity:

a	b		c
	d	e	
I	0	5	6
II	2	8	9
III	4	9	11
IV	4	7	12
V	5	8	12
VI	5	8	13

Description of columns:
a - Test number;
b - Number of remembered words;
c - Reference data for age 13 year;
d - Initial diagnosis;
e - Final assessment.

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