

The educational and technological aspects of the Alternative and Augmentative Communication (AAC)

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Abstract—AAC is the commonly used abbreviation of the term: *Alternative and Augmentative Communication* (AAC), which encompasses the different communication methods that can be used to help people with a wide range of speech and language disabilities. We shortly discuss several educational and technological aspects of AAC. We also consider the linguistic issues occurring in the learning and teaching processes of those methods of communication, in particular in conversation with pupils with special communicational needs. The efficiency of such conversation depends, first of all, on the level of acquisition of conversational abilities, but also on the suitable choice of a system of alternative communication (e.g., PCS - Picture Communication Symbols, PIC - Pictogram Ideogram Communication, Sclera Pictograms, MOWiK, Bliss System, Makaton), the proper choice of methods of communication, and the proper selection and use of the technological equipments (e.g., Voice Output Communication Aid, Boardmaker or Boardmaker with Speaking Dynamically Pro). Moreover, the persons that teach such communication should be on a high level of self-awareness and possess high qualifications.

There are various concerns that the use of AAC might impede their ability to speak using words, but some research records show that this is not the case in general and many applications of AAC facilitate speech production.

Keywords—AAC systems, education, technology, linguistic aspects.

I. INTRODUCTION

Communication between people is a natural need. It makes the exchange of information possible and allows to learn new values and skills, and therefore it is the main tool in education. It is essentially a two way process which involves some commonly agreed methods. People have developed several such methods, but the most commonly used are speaking and writing. Unfortunately, there are various reasons that can create some problems in using them. For example the physical disabilities and motor co-ordination problems may result in the obstacles making the production of speech or writing difficult or even impossible. Some of them are congenital conditions, e.g., such as:

cerebral palsy,
autism,
intellectual disability;

and acquired conditions, e.g., such as:

amyotrophic lateral sclerosis,
traumatic brain injury,
aphasia.

The other reasons can be some types of learning difficulties, which can make it hard to produce speech or handle spoken language. Several other impairments may occur in the production or comprehension of written language [2], [14].

The term AAC (Alternative and Augmentative Communication) encompasses the different communication methods that can be used to help people with a wide range of speech and language disabilities. Nowadays, AAC is a field of research, which uses scientific achievements of medical sciences, psychology, special pedagogy, linguistics, computer science and other.

In the recent years, we have observed a very rapid development of AAC. This concerns particularly applications of modern high-tech and low-tech devices, systems, strategies and methods invented not only to communicate, but also to teach persons with disabilities. Many pedagogists, teachers, psychologists and speech therapists learn how to use efficiently those various supporting AAC tools [5].

We should mention here that, generally, the AAC use does not need to impede the development of speech, and may result in some increase in speech production [2], [5].

II. HISTORICAL REMARKS

The first traces of use of augmentative communication can be found in classical Rome and Greece, where some strategies supporting the communication to the deaf people were recorded. There are also some records that in the 16th century Europe a manual alphabets and signs were used. In more modern times, in the 1920s, a men's group in Minneapolis distributed a communication board, created in cooperation with F. Hall Roe, who had cerebral palsy.

Modern use of AAC began in the 1950s, with an increasing commitment in the West towards the inclusion of disabled individuals in mainstream society. It speeded up during the 1960s and 1970s, when there were three, relatively independent, research areas that lead to the field of augmentative and alternative communication:

- (a) the work on early electromechanical communication and writing systems;
- (b) the development of communication and language boards;

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(c) the research on ordinary (without disability) child language development [1].

But it was not until the 1980s that AAC began to emerge as a separate field, because of rapid progress in technology (which included among others microcomputers as well as speech synthesis) that paved the way for various communication devices with speech output thus giving an access to communication for those with physical disabilities. Now we are observing further development in that field in the world and in particular in Poland. Many different methods have been proposed (e.g., the use of manual sign language and graphic symbols) that can be used as an alternative to speech and writing and/or to supplement them and support in this way the development of the skills that are required in the independent life.

Poet Christopher Nolan, physicist Stephen Hawking and broadcaster Roger Ebert are world-wide known users of AAC. Also, there are award-winning and well-known movies concerning the subject: "My Left Foot" and "The Diving Bell and the Butterfly". All this have made the lives of those who use AAC more familiar to a wider audience.

III. ALTERNATIVE OR AUGMENTATIVE COMMUNICATION

Whether we are to apply alternative communication or augmentative communication depends on:

- the extent of the defects of speech in connection with the degree of inefficiency of particular persons and
- the possibilities of adaptation of those systems of communication to the necessities of their lives.

So, we can distinguish two groups of users of AAC:

- the first: persons with the deficiency of ability of speech;
- and the second: persons with limited ability of speech.

The alternative communication takes place when persons use alternative systems during the conversation.

The term augmentative communication means the use of the supplementary systems of communication by people with limited ability of speech. The new ways of talking can be a support for the development of speech and/or to complement it [4], [14].

IV. AAC SYSTEMS

We mainly distinguish two types of AAC systems: the unaided and aided. Unaided communication uses no additional equipment and is based mainly on signing and body language. The aided communication use various external tools which can be only just paper and pencil, but also communication books or boards and modern devices generating speech (SGDs) or producing written output.

There are a lot of AAC systems, which are used in therapy and in education. The choice and the adjustment of a suitable system for communication depend on the type of inefficiency and on diagnosis of all spheres of the development. In particular, while choosing a suitable AAC system for a particular person we should take into account the individual's motor, visual, cognitive, language and communication strengths and weaknesses, but also the abilities of family

members, ethnicity and beliefs.

Let us mention, e.g., the following types of AAC systems:

- I. Spatial - tactile systems - for example blocks of Premack.
- II. Manual systems - for example language by signs (speech by signs), finger language, Coghamo gestures, phonogestures.
- III. Graphic systems - for example PIC (Pictogram Ideogram Communication), PCS (Picture Communication Symbols), Bliss system, Rebuses, usual alphabet, Mowik.
- IV. Tactile systems - for example:
 - for blind - Braille alphabet;
 - for deaf and blind: Tadoma method, Lorm method, finger language on the hand, tactile Braille on finger on one hand, tactile Braille on fingers on both hands, drawing capital letters on the hand, Kozłowski method - punctual alphabet.
- V. Mixed systems - for example Makaton - created by connecting the systems of pictures, gestures and speech [5].

The main object of the process of diagnosis is to evaluate the needs, potentiality and obstacles of life of AAC users. This is the foundation for making the individual plan of therapy and education. The process of assimilation of alternative or augmentative systems of communication is comparable with the learning of foreign language.

We can distinguish the following indicators of readiness for learning AAC systems, which concern the cognitive development and the development of communication and language:

- proper understanding of interdependence of notions: cause - effect, tool - purpose;
- awareness of steadiness of solid object;
- attainment of the level of symbolic thinking and symbolic function in language;
- possession of the skill of creation of personal interactions (in other words the ability of getting into the touch with other persons and keeping it) and followings the rules of mutual exchange activities (for example in dialog);
- the ability to express intentional meaning in activities (verbal and nonverbal) [13].

The task of a teacher in the AAC approach is to help in the construction of an individual communication system for each person. That activity tends towards achieving mentioned above indicators of readiness and is focusing on:

- preparation of fully responsible partners for communication (first of all the parents if possible);
- adaptation of the communication methods to the physical condition of a particular inefficient person;
- make advantage of the existing habits of communication through speech, natural gestures, touch;
- arrangement of special situations to make advantage of existing social, cognitive and communicative development (during games and everyday activities);
- methodical process of construction of individual system of symbols and signs.

When we use AAC with children, it does not mean that we neglect any support of speech development. The speech is always present in all activities of adult people connected to the children that have no ability to talk. The application of the method of augmentation communication presumes multiple

transmission of information towards a child. That means that the verbal input will be strengthened by a glance, a gesture indicating particular places or persons, presentation of the objects, manual or graphic signs depending on the stage of development of the child. In this way it will involve various systems of perception and improve understanding and the expression of communication [8], [12], [16].

V. POTENTIAL USERS

Individuals with the following specific disorders may profit from the use of AAC.

Autism is a well known disorder of neural development, which impairs social interaction and communication. It is characterized by a restricted and repetitive behavior with a particular difficulty to acquire expressive communication skills. Many individuals with autism may have serious difficulties in learning how to use spoken communication. In this case the AAC intervention can be directed towards the improvement of the linguistic and social abilities and facilitating the development of interactional skills. Quite often we should start with communication boards and/or object or picture exchanges [1].

Aphasia can be caused by a damage to the brain's language centers, which result in a chronic language impairment and often allows only a communication using a combination of speech, gestures, and aided communication with memory books, drawing, photography, written words, speech generating devices and keyboards [9].

Amyotrophic lateral sclerosis (ALS) or *Motor Neurone Disease (MND)* may lead to weakness and eventual paralysis. In this case we can apply a procedure known as voice banking (digital recording of words and phrases of a person while it is still possible, for later inclusion in a communication device).

Cerebral palsy (a non-progressive developmental neuro-motor disorder with an upper motor neuron lesion origin) can result in a wide variety of challenges including motor planning, control and coordination, depending on the location of the brain lesion. It may cause dysarthria, which is a speech disorder following a damage to the motor-speech system. Then AAC may provide a support for communication, especially that there occur also an intellectual impairment as well as the visual and hearing problems [1].

Developmental verbal dyspraxia (also known as *childhood apraxia of speech*) is a developmental motor speech disorder and involves the impairments in the motor control of speech production. The speech of a child suffering from it may be unintelligible and AAC methods can improve the production of it.

Intellectual impairment may be a serious obstacle in developing communication skills, in particular may cause problems with generalization. In such a case the AAC intervention emphasizes partner training and natural communication, which increases participation in activities, choice-making and perceptions of communication partners [1].

Locked-in syndrome caused by *strokes* result in profound deficits, in which cognitive, emotional and linguistic abilities may remain intact but nearly all voluntary motor abilities can

be lost. In many cases we can only rely on AAC strategies adjusted to the individual's preferences and, as eye movement are most likely to be preserved, communication can be based on it.

Traumatic brain injury may cause some severe motor speech disorders and one of the most common is *dysarthria*. AAC support should depend on the stage of recovery. If there is no chance for at least partial natural speech recovery, then it may facilitate the ability to express basic needs and answer questions. However, some well-established methods such as spelling may be sometimes more effective than AAC, because of an easier access to the information.

Also *Parkinson's disease* is characterized by dysarthria, which may later develop. The functional speech may be eventually lost to a significant degree and the AAC approach is generally used to supplement and support natural speech [3].

The most common communication problem in *multiple sclerosis* is again dysarthria, but some other disorders may occur, as well. For instance significant difficulties with speech and intelligibility may happen, with wide variety of motor control capacities and the presence of intention tremor.

Dementia with an acquired, chronic, cognitive impairment, is characterized by deficits in memory and other cognitive domains, where communication impairments are partly attributed to memory deficits. In this case AAC intervention can compensate for deficits and increase the ability to recognize material that cannot be recalled [3].

VI. LINGUISTIC ASPECTS OF AAC

The assimilation and the improvement of communication competence in pragmatic area is a very important issue in the AAC field. We mean the following skills: expression and understanding of utterances, attaining the level of intentional communication, the symbolic function level of language, acquisition of denotation of words, conversation abilities and nonverbal communication. The main problem is the acquisition of them in various situations of life. From research we know that impaired persons have significant problems in semantic and pragmatic area [15].

So, the following skills of conversation are very important:

- starting a personal contact and initiating a self-dependent participation in a talk;
- initiating a subject of a conversation;
- maintaining the subject of a conversation;
- exchanging activities during a conversation: speaking – listening - understanding;
- giving the feedback information;
- formulating question-tags and asking;
- expressing requests and questions to make an information more precise [6], [11], [12].

The main purposes of the linguistic investigations in the field of AAC are the following two issues:

- the improvement of the quality of communication skills of persons with various disabilities;
- the raising of the level of education for AAC users.

The analysis of utterances (colloquial texts) of children using AAC systems is one of the possible descriptive methods

that can be applied. We propose to investigate:

- organic structure of utterances;
- elements of the substance of utterances;
- ability to use the structure and substance of the text in the real communicational situations.

Spontaneous, colloquial utterances make the structure of the text and all transfer (input) of information contained in the structure of it refers to the following planes:

- verbal plane - (phonological, morphological, lexical, syntactic and stylistic);
- nonverbal plane - (e.g., kinetic, proxemic and vocalic, which includes accent, intonation, rhythm, and a sound of a voice).

Further, in connection with this we can analyze:

- information contained in the code (such as the verbal system, graphic system, gesture system - manual system, tactual system and others);
- pragmatic information, i.e., the knowledge of the speaking persons and conditions of communicational situation.

The category of modality seems to be especially interesting, as a one of pragmatolinguistic aspects. The attention could be focused on determination of the acquisition level of the modal constructions in the areas of:

- expressing different kinds of sentences, for example indicative, interrogative, imperative;
- using lexical exponents of modality in the structure of sentences;
- interpreting the illocution of utterances.

So, the formal structure and substance of text can be characterized by:

- colloquial conversational style in verbal and nonverbal plane of text;
- the usage of the codes of natural language and of alternative or augmentative methods in many contexts and in spontaneous situations;
- syntactic, semantic, pragmatic and cognitive rules of structure;
- individual usage of language components;
- individual intentions (illocution) in special acts of speech.

Recapitulating, the text as an act of realization of utterances needs an analysis of types of sentences, their modal intentions and illocution power.

In accordance with the assumptions of Construction Grammar, the interpretation of utterances should be based on recognition and reconciliation of the structure and the meaning of numerous constructions occurring in this sentences, since children acquiring language join and adapt many different constructions by adjusting and modifying them.

The improving of children's communicational and linguistic competences allows them to be more creative.

VII. TECHNOLOGICAL ASPECTS

We distinguish the aided AAC and the unaided AAC. The aided AAC assumes a use of various additional external tools that make the communication easier. Otherwise we have to do with the unaided AAC, which uses no equipment and includes mainly signing and body language.

Every device, either electronic or non-electronic, that is used to transmit or receive messages can be depicted as an AAC aid. They can vary from communication books to speech generating devices. The range of diversity of communication aids and devices is very large because the areas of communication needs, difficulties and skills of AAC users vary greatly [7].

In aided AAC we distinguish **low-tech** and **high-tech** approaches. Low-tech aids do not need batteries, electricity nor electronics and quite often they are very simple communication boards or books, which allow the user to communicate a message by a selection of proper symbols, pictures, letters, words, and/or phrases. The message can be indicated with a head/mouth stick, light pointer, body part or with an eye-gaze direction, depending on physical limitations and abilities of the users. This includes also the indication of *yes* or *no* while a teacher or partner in such a communication scans through possible options [7].

In high-tech aided AAC the applications of computers in the teaching process is the central part of the educational experience. Interactive software allows to progress in an individual speed and provide an immediate information on various aspects of the training. In the case of pupils with motor disabilities, the physical effort that is necessary in traditional writing can be diminished by the use of various technical devices such as interactive keyboards (also with an additional equipment), special types of mice, special software with systems of graphical Picture Communication Symbols, Pictogram Ideogram Communication, Brail systems.

An interesting feature of the high-tech AAC tools is that they permit the storage and retrieval of electronic messages and quite often allow next to use a speech output - they are called the speech generating devices (SGD) or voice output communication aids (VOCA). The speech output can be produced in a digitized way and/or synthesized (using a prerecorded material). Certainly, in many situations the digitized way is more convenient, because it permits to spell words and speak novel messages [9].

Picture Communication Symbols (PCS) is a graphic system that is very popular in particular in Poland. It may support communication of people with the mobility disabilities. Every teacher using it is must learn how to apply advanced technological tools with a suitable software, such as Boardmaker or Boardmaker with Speaking Dynamically Pro, to generate PCS symbols.

Boardmaker contains 4500 basic symbols of PCS that can be applied in printed communication boards. The symbols visualize objects, actions and concepts. The teachers can add various new visuals even in the form of colored or black and white photographs, line drawings or written words. In this way a personal learning book can be created for a pupil. The book may gradually increase its volume with the progress in the understanding and ability to express new meanings.

Boardmaker with Speaking Dynamically Pro is designated for the advanced users with significant speech or language disabilities and needs of more advanced alternative communication. It has additional functionalities, which

includes voice synthesizer: Real Speak. It can transform any computer into a speech output device and a powerful learning tool. There is a possibility to use Boardmaker with Speaking Dynamically Pro on a tablet with a touchscreen, and thus obtain a possibility to display at once, with the synthesized voice, the name of every touched symbol [17].

The Voice Output Communication Aids are other high-tech AAC tools, which are, in general, light and portable. They can range from complex computer-based systems (that can store numerous messages and are equipped with a computer-synthesized voice) to simple single-message devices using recorded speech [6].

Also, the usual computers turn to the high-tech AAC systems when they run additional software that allow them to function as AAC devices. The recent development in smartphone and tablet technologies open possibility of a radical change in the availability of flexible communication devices. For example, Android and some other open source operating systems can supply real opportunities for small AAC communities to develop convenient features and software. But in all cases a suitable interfaces are needed that meet the various physical and cognitive challenges of AAC users. Moreover, all solutions that require special programming usually tend to be unreliable and in the case of their failure a backup of low tech systems is very useful.

High-tech systems also include solutions that are based mainly on a keyboard and do not require programming. For instance a keyboard, with a Text to Speech converter, can be used to create speech over a telephone. Also, a keyboard and an audio speaker can be configured to create a "talking keyboard" where the audio device speaks directly the typed text.

As we see, the high-tech devices may differ in various aspects. The amount of information that they can store can be very small or quite large. Also their size, weight and thus their portability can be more or less convenient. The same concerns the access methods, which may be through pointers, adapted mice, joysticks, keyboards, switches and/or scanning; but also a direct use of selection of symbols on the screen may be possible [10].

It seems that in the near future the possible directions of development of high-tech tools for AAC will be mainly: improvement of the interfaces, reduction of the cognitive and linguistic demands, and the decrease of the barriers to effective social interaction. Promising possible areas of development also include the devices using brain activity measuring electrodes, speech recognition systems making an automatic transcription of dysarthric speech, or recognition technologies that interpret signals from the body motions.

Usefulness of any high-tech and/or low-tech tools of AAC in communication depends on the proper choice of suitable supporting devices. Every such a choice should be preceded by the process of full evaluation, which should include for example the estimation of the possibilities of the user, a description of the potential partners of such conversation (e.g., members of the family, friends), and the environmental conditions in which the process of such communication takes

place. In particular, we should estimate the possible motor abilities, acceptable positions, communication skills and needs, the levels of hearing and seeing, and finally the understanding of words and graphic symbols or gestures. Also, the communication partners may need a suitable training to be able to understand or even to notice the communication signals and to interpret them consistently.

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