

Mental mapping of space in an individual with visual disability

(scientific paper)

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Abstract: *The mental mapping of space in an individual with visual disability may be viewed from several perspectives just as it is in any person, a bio-psycho-socio-spiritual being. On one hand mental mapping may be viewed in terms of the special pedagogy training in spatial orientation and independent movement in persons with visual disability and on the other hand the theme is closely related to typhlopsychology – meaning the process of the creation of a mental map. An important role is undoubtedly played by the lower and higher compensatory mechanisms. In a person with visual disability the hearing, the touch and partly also the smell and the taste together with mental processes participate at the information intake, its following processing and evaluation. The perceived is then processed using the concentration, the thought processes including analytic-synthetic activity, the memory and the imagination. The perception and the imagination, as parts of the conscious processes, form an integral part of the research on consciousness that is currently the target field of contemporary research tendencies.*

Key words: *person with visual disability, spatial orientation and independent movement, mental mapping*

1 Introduction

An individual with visual disability is before all else a human, a bio-psycho-socio-spiritual being. The ability to move in space is in this individual greatly influenced by the visual disability, external and internal factors. Independent movement in space is dependent on the training of lower and higher compensatory mechanisms. To achieve a successful orientation the individual creates in his or her mind a so called mental map of space. The process of mental mapping in this sense and the form of the mental map entails certain characteristics in our target group.

2 An Individual with Visual Disability

According to Finková, Ludíková, Růžicková (2007) a person with visual disability may be defined as an individual with an eye disease whose perception remains impaired even after optimal correction to such extent that it creates problems in daily activities. Vágnerová (2008) adds that an individual with visual disability is a person who is incapable of correctly and easily perceiving all visual information and this dimension of the external world is fully non-existent for him or is limited. It should be added that the external world of a person with visual disability consists of many dimensions. These lead to the reception and processing of information of various quality and quantity. According to the theory of information the bio-psycho-socio-spiritual aspect of information may be mentioned in the context of a holistic approach to a human being. The aspect of information in special pedagogy of people with visual disabilities is closely related to compensation. Edelsberger et al. (2000) define compensation as an enhancement in function of one organ as a reaction to the diminished function of another. Among the lower compensatory mechanisms are the hearing, the touch, the smell and the taste whilst among the higher are memory, concentration, thought and imagination. The result of this is that the hearing, the touch, the smell and the taste are involved in the process of mental mapping of space as much as memory, concentration, thought and imagination. What also influences, to a great extent, how an individual uses information in the process of creating a mental map of space is the will and emotions.

Besides characterising a person with visual disability from a holistic point of view and defining the term 'compensation' the subject of space, spatial orientation and independent movement of individuals should be addressed. Space may be defined as an area into which objects are placed and is given certain boundaries (Jesenský, 2007). A person in space moves and accomplishes daily activities. The successful orientation is dependent on internal factors, e.g. the individual; and external factors, such as measures in traffic, public areas or buildings (Wiener, 1986). The term 'orientation and mobility' used in English-speaking countries is, in the context of education, described as learning concepts, abilities and techniques necessary for a safe, effective and elegant movement of a person with visual disability in the environment, under various conditions and situations. Orientation is considered to be an ability of an individual to use the respective senses to understand the given placement in the environment in a given moment (Jacobson, 1993). Mobility is then defined as a set of movements enabling the repositioning of the body and the accomplishment of work (Hartl, Hartlová, 2000). In the case of a person with visual disability it means a complete regaining of abilities and inclusion in all spheres of life (Wiener, 1986). Finková, Ludíková, Růžicková (2007) further specify the methodology of training in spatial orientation and independent movement which consists of mastering elements

of spatial orientation and independent movement, the technique of white cane and orientation analytical-synthetic activity. The basic elements comprise of human guide walking, self-protective postures, and the so called trailing technique. The white cane technique further requires the mastering of basic holding, the trailing, the pendulum and diagonal technique. Orientation analytical-synthetic activity is represented as work with orientation points and signs detectable on the path through senses. It must be added that certain theoretical basis for the mental mapping of space in people with visual disabilities may be seen in the orientation analysis and synthesis.

3 The Mental Mapping of Space in an Individual with Visual Disability

The mental mapping of space in an individual whose dimension of visual perception of the outer world is impaired is very specific. The simple diagram below (Fig. 1) clearly shows that the individual with visual disability enters the process of mental map creation as an independent entity using lower compensatory mechanisms with the inner dimension and the potential of higher compensatory mechanisms. Movement in space then takes the meaning of a part of the dimension of the outer surroundings, the physical world that surrounds the individual. In the process of the mental map creation the inner and outer dimensions interact in an individual and these areas may overlap.

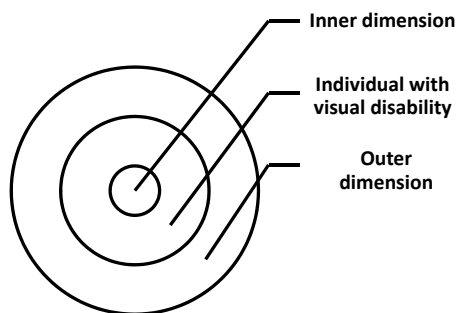


Fig. 1: The dimensions of mental mapping in the spatial orientation of an individual with visual disability

As part of the mental mapping of space the so called perceived space and action space is considered. The perceived space is a subjective mental representation of the surroundings. Every person chooses different stimuli of the surroundings within this space that then receive attention (different things and situations are interesting, different elements of the surroundings serve orientation, different emotions are felt, different memories are created). The action space is represented by that which is at the given time on the person's mind. Moreover, in the practice of spatial orienta-

tion and independent movement other spatial stereotypes are used which practically means that in most cases a person has a tendency to use routine and known places. It is known as some kind of space of activities, a mental image of the surroundings with a concrete, quite stereotypical way of using space (based on http://ucitele.sci.muni.cz/materialy/86_1.pdf). This leads to the conclusion that the mental mapping of space in a person with visual disability consists of inner and outer dimension, perceived and action space.

However, it is obvious that it is a process that can be divided into certain logically connected phases. In the process of mental map creation the basis is formed from the information within the outer dimension that the individual perceives through senses. The information is taken to the brain for processing and creation of an image of the environment. The process of mental mapping of space is defined by these four basic stages:

- Information intake using the senses.
- Selection and conscious processing.
- Memorising the spatial image.
- Decision-making, movement and orientation based on the memorised image (http://ucitele.sci.muni.cz/materialy/86_1.pdf).

If we were to apply the above mentioned stages to our target group certain differences would arise. These can be summarised in the following form in harmony with the methodology of the spatial orientation and independent movement training of a person with visual disability:

- Acquiring information using the lower compensatory mechanisms or the remnants of sight.
- Using the higher compensatory mechanisms to select data and process information.
- Memorising the spatial presentation of space while considering the differences in acquiring and processing of information.
- Spatial orientation and independent movement of an individual using the mental mapping of space.

The outcome of the process of mental mapping in spatial orientation and independent movement of a person with visual disability is a mental map. The form of the mental map of the individual is in the end dependent on the developmental level of the lower and higher compensatory mechanisms. Differences are expected at the level of the senses because of impairment in the visual information perception. Among the higher compensatory mechanisms the level of memory, concentration and imagination is important (Majerová, 2014).

4 The Possibilities of the Development of Mental Mapping in Spatial Orientation and Independent Movement of an Individual with Visual Disability

4.1 Current Research Tendencies

Research connected with the names Lahav, Moiduser (2011) was undertaken at the Tel Aviv University in Israel. The main goal of the study was the development of haptic virtual surroundings for the effective creation of cognitive maps in individuals with visual disability (with the support of a Microsoft company grant and the Ministry of Education in Israel). Below are cited the published results of this study.

In mental map creation two main scanning strategies are used: the route strategy and the map strategy. The route strategy is based on linear spatial characteristics while the map strategy involves multiple perspectives of the target place. People with blindness usually use the strategy of the first type, however, the necessary spatial information acquired using the compensatory sensory channels contributes to the mental mapping of the surroundings that can lead to the improvement in spatial orientation in these individuals.

Three basic areas are being mentioned by authors in connection with the theme of mental mapping: the development of multisensory virtual surroundings (which enables people with blindness to know the surroundings); a systematic study focused on a complete arousal of the abilities of people with blindness using the virtual surroundings; the research of the import of this mapping for people with blindness in connection with the development of their touch.

The haptic virtual environment in the research enabled the individual to actively learn the mental map creation using the compensatory sensory channels (the compensatory mechanisms). The real space in which the individual lives was simulated using the multisensory virtual environment. In the research the virtual environment used two modes of operation: the teacher mode and the learning mode. The teacher mode enabled to define the characteristics of the environment (the size of the room, its type, objects and their character, the door, windows, the types of floors with their sound characteristic like the wooden floor or grass, etc.). The editor provided haptic as well as sound response. The learning mode included operations for students and teachers. The user was able to walk through the virtual environment using the feedback joystick and receiving haptic response received by feet in the given environment through the joystick (texture, surface imitation), and a sound response (names of objects in the environment, the sounds of the windows and doors). The individual moved in the virtual environment using navigation that enabled to react to situations when the individual got lost in the virtual environment.

In the research virtual environment was used and subsequently observed how an individual with blindness can use it in the construction of cognitive maps and orientation in real space. The individual first moved based on the instructions in the virtual environment and later was to transfer into the real space. The advantage of the virtual environment was the possibility to use repeated mapping of space (room) which gave the individual enough information and an abundance of feedback. Lahav, Moiduser (2011) assume that these virtual instruments could become good additional means for the blind in the learning process in understanding new phenomena and events of real world. More can be found by the reader in the author's text that introduces the research as such (<http://muse.tau.ac.il/publications/99.pdf>).

Although the world of technology is constantly expanding we do not consider this trend as the only direction of development in special pedagogy. The special pedagogy of people with visual disability as human science should not in time become a virtual system science contrary to the great influence of technology. The special pedagogy is a science about a living system and not about the artificial. We do not disregard the involvement of technological devices into education, socialisation, the support in the development of individual personality, nevertheless, we emphasise the importance of special pedagogy to remain a science about a human being. Below we will mention additional possibilities of the development of abilities within the mental mapping in a person with visual disability from another perspective besides the information-communicative.

4.2 The Focused Attention within the Spatial Orientation of an Individual with Visual Disability

An individual with visual disability must be able, during orientation in space, to immediately concentrate, evaluate and solve current spatial situations. People use mental maps in practice naturally, nevertheless, it may be stated that it is possible to improve the process of their creation and implementation. At this point we would like to stress the importance of training the lower compensatory mechanisms as well as the ability to concentrate, immediately relax and use all available information from the inner and outer environment of the organism. It is possible to increase stimulation of higher compensatory mechanisms and secondarily also the lower ones using the higher within practical situations through various stimulatory exercises directed at mental hygiene and visualisation. The permanent and adequate stimulation of nervous system is considered crucial. In the final academic paper Majerová (2014) introduces advice for practice in the form of attention, imagination and memory training.

Referencing attempts described in academic literature Požár (2000) confirms that the auditory attention is more differentiated and has wider range in blind people. The individuals are capable of narrow differentiation and permanent focused attention.

Nakonečný (1998) adds a definition of attention as a state of organism activation that enables conscious adaptive reactions. It must be added that individual training of attention in a person with visual disability requires outer as well as inner stimuli. For immediate relaxation in a difficult situation in space we recommend conscious attention training using daily mental hygiene for example in the form of breath exercises, relaxation and meditation training, concentration training using a focus point (the term originates from yoga; it is a point the person concentrates on while consciously breathing), etc. Hypothetically it may be stated that regular stimulatory exercise influences the central nervous system, improves attention and secondarily enables a more effective creation and implementation of mental maps in spatial orientation. These exercises support development through the individual's own actions rather than through technology or computer systems only.

4.3 Stimulating Imagination

Regarding the imagination of a person with visual disability Lopúchová (2010) defines imaginations as a higher level of a sensory image which, however, is not a simple copy of sensory experiences. Impaired or completely lacking vision influences imagination while the structure of the visual stimuli consists of current visual perception and past experience of the individual. Visual imaginations are, therefore, due to the impaired visual perception, different. We would like to add that imagination training practically means stimulation of this higher compensatory mechanism but in this way we may also support the training of the lower compensatory mechanisms used in daily life.

Imagination improves during daily activities performed by a person with visual disability together with the compensatory mechanisms through immediate experience. Mental hygiene exercises may also contribute to a more effective implementation of imaginations (mental maps). The use of imaginations in autogenic training is known to most workers of helping professions. In practice a person may include visualisations in the form of mental involvement of a concrete sense in the concentration training. A person who became blind later and is learning to read the Braille writing may in this way imagine for example perceiving clearly and prominently the text in Braille, trailing the paper and clearly perceiving the writing through fingertips. Such visualisation may be used also in the typhlographics training including the reading of typhlographic maps, plans and other images. Moreover, stimulating the imagination of clearly recognising typhlographic images, using the cutaneo-muscular apparatus and touch in general works as a positive stimulation for practical training, as a motivating factor. This kind of daily activity does not need to take more than several minutes during which the individual carries out relaxing exercises and then the visualisation. Similar training may be advised also within the training of dif-

ferentiating sounds as part of spatial orientation (the individual consciously thinks of various sounds the differentiation of which has been mastered during practical training). Similarly, smell and taste imaginations may be included and eventually, the individual may combine all the mentioned compensatory mechanisms within a concrete or model situation in a visualisation exercise.

4.4 Memory Training

Regarding the memory we repeat the above mentioned process of creating a mental map of space in a person with visual disability in regards to memory mechanisms. The process works in the following way: acquiring information through lower compensatory mechanisms, or remnants of vision → implementation of higher compensatory mechanisms in data selection and processing → memorising the space image with differences in acquiring and processing information → spatial orientation and independent movement of an individual using the mental mapping of space. This process of working with information and the creation of a mental map are specific in a person with visual disability but are still subject to the general biological and psychological laws. Generally propagated and existing approaches may, therefore, with minor changes be applied. For example Preiss, Křivohlavý (2009) created a title called “Training memory and cognitive abilities” that may be an inspiring resource for a typhlopedic’s practice. Lopúchová (2010) adds that the acoustic and word memory becomes, as a compensation to the increasing demands, sharper and better in people with visual disabilities compared to the intact. Memory and cognitive activities training thus becomes an integral part of daily life.

In the above mentioned literature comparison and practical exercises we have not exhausted the possibilities available in the field of mental mapping of space support. The text should serve as an inspiring resource for further study and practical activity.

5 The Neurobiologic View

Two types of information transmission function in the nervous system: the synaptic and the extrasynaptic (the glial cells communicate with neurons using ions in the intercellular fluid). The processes generated by the brain in analysing an image or realising the state of consciousness and others cannot be interpreted solely based on the neuronal or extraneuronal signal transmission. The quantum mechanics is a part of the quantum physics but contrary to the Newton mechanics it uses the wave and probabilistic character of particles that are part of matter with qualities such as energy, electric charge and spin. Each submicroscopic particle has a dual nature, the wave and the corpuscular. The particles perform motion and assume position

undefined in space and time (non-locality). However, once they come into interaction with the environment, the collapse of the wavelength of the particle occurs. The collapse occurs at the instant of measurement and can affect a considerable area. On top of the mentioned physical description of quantum phenomena Dylevský (2009) adds that **in the central nervous system the quantum processes may happen in intercellular space limited by the cell membranes that are impermeable for many elements**. It is the intercellular space that functions as a vast communication channel in which **the quantum transport of particles from any place in the system is possible without the movement of particles between the spaces**.

In quantum physics this is possible due to the mentioned collapse in the intercellular space (the decoherence of the wave function of the particles). This intercellular space is limited by membranes with high ohm resistance. What is important is that quantum phenomena happen at the level of atoms, ions and all (some) small molecules. However, in the central nervous system it is mostly the calcium ions that play a role in intercellular communication, although it is also electrons loosely bound in ionised forms, or smaller molecules of protein and fat, neurotransmitters and neuromodulators (peptides). **Quantum changes occur in the structures of the brain constantly, constantly creating new connections, while those necessary for the given momentary state of the system are selected. In the quantum communications transmission is probably of the relatively simple information.** Quantum information transmission principles are still being researched. **In the central system, according to the quantum theory, “everything” should be linked to “everything”.** In practice in humans, there first are established short-term connections which can later become more permanent. When asked whether the quantum theories are realistic we may explore the brain development in fetus and child. The activity of the nervous system of the child is affected by apheresis, in other words the dominance of information supply and the trends of functions, or memory. Initially the fetus and infant brain has no trend – it responds only to the current range, and only gradually builds up the continuity of functions. In this way, the brain of a child corresponds better to the quantum model, while the adult brain to the newton model (Dylevský, 2009).

The individual with visual disability also cannot be excluded from the possibility of quantum theory application in terms of the nervous system functioning. A hypothesis that the particle transmission is possible to any place in the system without particle motion between these places in a system where “everything is connected to everything”, is thought-provoking. From this perspective, active stimulation of the center takes on a new dimension, we believe that adequate stimulation may promote the development of those parts of the brain that are, in such individuals, involved to a limited extent or not at all. At this point, the question of plasticity of the human brain is of great importance, as highlighted by Kulišťák (2011).

6 The Conclusion

The mental mapping of space in an individual with visual disability concerns the neuroscientific as well as the special-pedagogic dimension. The spatial orientation and independent movement training in people with visual disability has its full methodology, nevertheless, we emphasise defining the mental mapping of space as an independent field within the spatial orientation of an individual with visual disability. Focused training of mental mapping of space in an individual with visual disability has its theoretical and practical foundation.

Literature

- DYLEVSKÝ, I. (2009). *Speciální kineziologie*. Praha: Grada.
- EDELSBERGER, L. a kol. (2000). *Defektologický slovník*. Praha: Nakladatelství H&H.
- FINKOVÁ, D., LUDÍKOVÁ, L., RŮŽIČKOVÁ, V. (2007). *Speciální pedagogika osob se zrakovým postižením*. Olomouc: Univerzita Palackého.
- HARTL, P., HARTLOVÁ, H. (2000). *Psychologický slovník*. Praha: Portál.
- JACOBSON, W. H. (1993). *The Art and Science of Teaching Orientation and Mobility*. New York: American Foundation for the Blind.
- JESENSKÝ, J. (2007). *Prolegomena*. Praha: Univerzita Jana Amose Komenského.
- KULIŠŤÁK, P. (2011). *Neuropsychologie*. Praha: Portál.
- LAHAV, O., MOIDUSER, D. (2011). *Blind persons acquisition of spatial cognitive mapping and orientation-skill supported virtual environment*. Retrieved from <http://muse.tau.ac.il/publications/99.pdf>
- LOPÚCHOVÁ, J. (2010). *Reedukácia a komplexná rehabilitácia zraku u jednotlivcov so zrakovým postihnutím*. Bratislava: Univerzita Komenského.
- MAJEROVÁ, H. (2014). *Mentální mapování prostoru u osob se zrakovým postižením: Závěrečná písemná práce*. Olomouc: Univerzita Palackého v Olomouci, Pedagogická fakulta, CCV.
- NAKONEČNÝ, M. (1998). *Základy psychologie*. Praha: Nakladatelství Akademie věd České republiky.
- POŽÁR, L. (2000). *Psychologické děti a mládeže s poruchami zraku*. Trnava: Trnavská Univerzita.
- PREISS, M., KRÍVOHLAVÝ, J. (2009). *Trénink paměti a poznávacích schopností*. Praha: Grada.
- UCITELE.SCI.MUNI.CZ. (2010). *Geografie: Mentální mapování*. Brno: Masarykova univerzita. Retrieved from http://ucitele.sci.muni.cz/materialy/86_1.pdf
- VÁGEROVÁ, M. (2008). *Psychopatologie pro pomáhající profese*. Praha: Portál.
- WIENER, P. (1986). *Prostorová orientace a samostatný pohyb zrakově postižených*. Praha: Avicenum.

(reviewed twice)

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