Motor competence in visually impaired persons

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Content

Preface

One of the many reasons for making this text available is the fact that there are only few books addressing the issue of physical activity in visually impaired persons. This applies both to children and adults. Another reason is the fact that a number of visually impaired children are integrated in common schools. Visually impaired pupils cope well with most school subjects in cooperation with special education centres. An exception is physical education. So far, there is an insufficient number of qualified adapted physical educators, and traditional PE teachers are not sure if they are able to deal with this issue. Therefore, upon agreement with parents and physicians they choose to exempt a visually impaired child from mandatory PE lessons for 'health reasons'. Currently, this is usual practice evidenced by our long-lasting experience from seminars on integrating visually impaired children in PE lessons held for PE teachers and employees of special education centres. We believe that this is not a step in the right direction. From professional perspective, this situation is absolutely unacceptable. An insufficient level of motor competence in visually impaired children can be a seriously limiting factor in everyday life as well as future professions although the child's intellectual abilities can be above-average. Let alone the negative influence of hypo kinesis on human health. A similar situation is observed in the area of physical activity and particularly physically-oriented activities in visually impaired persons.

Our findings are equally intended for parents, teachers, educators, trainers, coaches and other staff working with visually impaired individuals of all ages.

An important target group of this text are the students of adapted physical education, adapted physical activity and other fields involving physical education. These persons should particularly focus on the theoretical sections of this book that should provide an appropriate insight into their future professions.

The authors

1/

Terminology

Zbyněk Janečka, Ladislav Bláha

Professional terminology underpins the clarity of any scientific text. Let us provide the perspectives of some of our authors, who are listed below in an alphabetical order.

Bláha and Pyšný: "We believe that the ***visually handicapped population*** does not have optimum conditions for maintaining let alone cultivation of health-oriented fitness, on the contrary, they are largely affected by hypokinesis as a consequence of their impairment" (Bláha & Pyšný, 2000, 8). Both authors also use the term ***visually impaired*** (Bláha & Pyšný, 2000). None of the terms is specified in more detail.

Čálek: "The importance of the mother's reaction for the development of a ***blind child*** will be…" (Čálek, 1984, 15). The same author also uses the terms ***congenitally blind child*** (Čálek, 1984), and ***severely visually impaired person*****,** or ***person with severe or complete loss of sight*** (Čálek, 1986). None of the terms is specified in more detail by the author.

The defectological dictionary defined the term typhlopaedia as follows: "…scientific discipline dealing with special education of ***visually impaired persons*****"** (Defectological dictionary, 2000, 367).

Flenerová (1985,11): "***Visually impaired persons*** represent a category of persons requiring special care (i.e. specific care – author's note) and are, from a special education perspective, children, young people and adults, whose defect lies in a disorder of the visual analyser that causes impaired visual perception as a consequence of a visual malfunction".

The author classifies the stages of visual impairment as follows:

Persons:

- Visually impaired
- with remaining vision,
- blind,
- amblyopic and squint-eyed.

These terms and then defined. As an example, the author's definition of visually handicapped – blind persons is provided below: "***Blind persons*** represent a category of ***visually impaired*** persons and include children, young people and adults, whose visual defect is a malfunction or disorder of the visual organ in an extent that causes deterioration of visual perception equal to blindness" (Flenerová,1985,14).

Jesenský: "…education of the ***visually handicapped…***" (Jesenský, 2002, 9). „***…the visually impaired*** are mostly limited by…" (Jesenský, 2002, 12). "…almost 2/3 of interviewees believe that ***severely visually impaired persons*** despite their ***handicap*** are motivated…" (Jesenský, 2002, 13).

Jesenský is one of the few authors who defines special education terminology without inclining to the more frequently used opthalmological specification.

Jesenský thus considers ***visual impairment*** "…more than a mere damage (pathology, defect) to the anatomic structures and a disorder of the visual analyser function. This is a condition in which such damage or disorder negatively affects all dimensions defining the quality of life of a human…" (Jesenský, 2002, 25).

As far as the frequency and use of special education terms are concerned, Jesenský adds: "The negative nature of the mentioned deviations represents a ***disadvantage – handicap*** compared with non-disabled individuals. This constitutes a reason for the second most widely used term: ***visually handicapped*** (VH) in addition to ***visually impaired (VI)***" (Jesenský, 2002, 25).

As far as the classification of visually handicapped persons is concerned, Jesenský adds that "the indicators and criteria of the opthalmological type also lie in the classification of VH groups and related terminology" (Jesenský, 2002, 27). "This is a brief definition of the generally acknowledged symptoms of visual or sight damage. In principle, the classification covers the following main groups:

- blind,
- with remaining vision (remnants of sight, virtually blind)
- visually impaired (severe, medium, light)
- binocular disorder (amblyopic, squint-eyed, single-eyed)" (Jesenský, 2002, 27).

Jesenský further adds: "…considering the future emancipation and identification of typhlopaedia, a greater emphasis might be placed on criteria that will highlight ***visual handicap*** and other related indicators instead of damaged vision. In this context, the term ***person with specific needs*** is used more frequently today" (Jesenský, 2002, 29).

Květoňová-Švecová: "The following paragraph deals with sensory deprivation that mostly affects ***visually impaired children***" (Květoňová-Švecová, 2000, 41). In order to specify the degree of visual defect, the author uses an opthalmological perspective based on visual acuity, impairment of the visual field, oculomotor issues, colour perception disorders and difficulties with visual information processing.

Ludíková: "Typhlopaedia is a pedagogical discipline that does not focus on general education but special education of the ***visually defective***" (Ludíková, 1988, 7). "To understand the current objectives and tasks of schools designed for ***children with visual defects*** it is necessary to…" (Ludíková, 1988, 25). "In this context, the socialization of the ***visually impaired*** is a process during which ***severely visually impaired individuals*** gradually grow into…" (Ludíková, 1989, 11). From a typhlopaedic perspective (Ludíková, 2005, 192) "…***an individual with visual impairment*** is considered any person that has continuing problems with visual perception and visual information processing in usual life even after an optimum correction of their visual disorder."

For a more precise differentiation of visually impaired persons the author uses a categorization system based on opthalmological perspectives: blind persons, persons with remaining vision, blind persons, persons with binocular vision disorders.

Štréblová: “During the course of life, ***a visually impaired child*** is in contact with the surrounding environment…” (Štréblová, 2002, 41). This term is adapted according to Flenerová (1985).

Vágnerová: “The attitudes to ***visually handicapped persons*** is clearly affected by generalization…” (Vágnerová, 1995, 7). “***Visual impairment*** is not only a matter of an individual but becomes a ***social handicap***” (Vágnerová, 1995, 7). “The reactions of ***severely visually impaired children*** tend to vary…” (Vágnerová 1995, 54). As far as the term ***visual impairment*** is concerned, the author adds: “…this is a general term identifying a group of diverse diseases and disorders, whose only common feature is that they limit the ability of visual perception. However, their variety is much larger, each defect has specific features that can diversely influence the development of impaired children and their lives” (Vágnerová, 1995, 12). Therefore, the author emphasises working with individual diagnoses of individual children.

To determine the severity of the defect the author again uses opthalmological terminology with a visual acuity criterion. “Visual acuity is the accuracy of visual differentiation and is measured in terms of an ability of close as well as distance vision…. Orientation in an environment and ease of obtaining information of this type depends on the extent of visual perception, i.e. on the functional visual field” (Vágnerová, 1995, 11, 12).

Vašek: “In compliance with the current classification of special education in various cultural environments we tend to adhere to the following classification: “education of physically impaired and health affected individuals, education of ***visually impaired individuals*** …” (Vašek, 1994, 216).

Let us conclude the terminology overview with several thoughts as published by Požár.

“Terminological discrepancies relating to individuals with various types of impairment have existed for a long time. We all remember the previously used pejorative term ***defective***. In our country this term was replaced by ***individual requiring special care***, which is an apt term but quite lengthy. Moreover, there is an issue related to identifying different types of impairment. In this context, how do we call a person that has problems seeing or hearing? As an ***individual requiring special visual care*?** This is surely disputable. Therefore, the term ***impaired*** started to be used although it has a certain negative emotional connotation. Apart from that, an individual can be impaired in various ways (e.g. politically, or victim of a robbery, etc.) However, this no longer caused problems with identifying various groups – ***visually impaired***, physically impaired”… (Požár, 2002, 67, translated). Požár continues with an analysis of most frequently used terms. We adopted the American term ***“handicapped”,*** which was mostly left untranslated (sometimes translated as ***“disadvantaged***”); the term is sporadically used even today… In the Czech Republic the term ***“health impaired”*** is frequently used. This provides some advantages as the term clearly denotes what caused the impairment, although it depends on what we understand by “health”. Is a mentally impaired individual or an individual with a communication disorder ill? (Požár, 2002, 68, translated). As far as the use of other terms is concerned, Požár adds: “In a number of cases some apt or generally acknowledged and clear terms were abandoned because in the course of time they gained a pejorative connotation. For example instead of deaf we started to use ‘not hearing’ (although the term deafness as well as deaf-blind remained), instead of blind we started to use ‘not seeing’ (although the term blindness and some others remained), instead of invalid – health impaired.” (Požár, 2002, 69, translated). Which term does Požár prefer? Wherever allowed by the context, he recommends the term pupil, child or individual with a certain type of impairment. "For example a pupil **with *visual impairment,*** not a ***visually impaired*** pupil" (Požár, 2002, 69). He further recommends that authors use a single consistent term. Various terms lead to disunity and ambiguousness.

In this context, Květoňová-Švecová add that: "the development of terminology is, or should be, in compliance with the changes in the field of special education. Currently the classification to various "paedias" is gradually being abandoned because the subject of or one of the paradigms of special education is not the impairment (handicap) but the child, pupil, client with a certain issue that occurs during their education" (Květoňová-Švecová, 2000, 9).

The term **"otherwise visually equipped *child, client, person*"** is Janečka's contribution to the discussion. This is a wide and open term. In our opinion, the term covers the whole issue of visual defects from the least to the most severe ones. Even a person suffering from presbyopia (from the Greek presbys = old, óps = eye, Defectological dictionary, 2000) is unable to read small letters without glasses under inappropriate illumination. This is not a major issue but such person is not fully visually competent without glasses, and therefore can be considered otherwise visually equipped. Moreover, this term surpasses some terms that have a pejorative connotation judged by today's perception (especially by children and young people): ***"defect, defective, blind, handicapped"***. Respecting this "unlikeness", we perceive the personality of an otherwise visually equipped person as an integral part of the whole society surpassing today's thinking represented by the term integration. However, we are aware of the fact that this definition respects rather the philosophical dimension of the issue (compare Jesenský, 2002; Požár, 2002). In scientific research studies focusing on otherwise visually equipped persons, where their visual defect has to be clearly and exactly defined using a certain degree, level, etiology, etc., the visual "unlikeness" must be complemented with opthalmological criteria as acknowledged by a majority of the mentioned authors. This in principle includes the following groups: ***blind persons, persons with remaining vision*, visually impaired, *persons with binocular vision disorders, persons with colour perception disorders***.

The area of kinanthropology frequently uses a classification system based on the IBSA standards (International Blind Sport Association) used in the field of sport. This classification is international and clearly defined for the area of sport (see specification of B_1, B_2, B_3 categories on page 12 of this paper).

In German-speaking countries and regions the superordinate term for visually impaired persons is **"Sehgeschädigte"** (… with visual damage). Scherer et al. (1983, 10) considers various degrees and types of damage to this particular sense, from mild visual impairment (**Sehbehinderung)** to complete blindness (**Blindheit**). A visually impaired – limited individual (**sehbehindert-beeinträchtigt**) is a person who in spite of optimum corrections of the visual defect has only strongly limited vision (**Sehvermögen**). The term **"low vision"** is also gradually being introduced. Lower degrees of blindness are marked by the term "blind" (**Sehschwäche**), higher degrees are identified as "legal blindness" and "blindness" (**gesetzlich blind und blind** – equal to practical blindness and blindness – author's note), also in relation to social security.

English terminology has the terms **"visual impairment"** and **"blind(ness)"**, which can be referred to as impaired vision and loss of vision. Visual impairment (sometimes also **"vision impairment"**) is understood as a loss of or a considerable decrease in the ability to see caused by a disease, injury or congenital defect, or as a result of degeneration that cannot be corrected in a usual way including refraction, medication or surgery.

Some texts include the term **"visually disabled"**, which translated into Czech would correspond to *visually impaired*, i.e. "persons with impaired vision". For ethical reasons this term is nowadays used in connection with "persons, pupils", etc. The terms **"visually handicapped"**, **"handicapé visuel"** (French), **"persona con discapacidad visual"** (Spanish) would correspond with the Czech "visually handicapped person" or "person with a visual handicap". We should understand however that a ***handicap*** is understood considered a ***"...disadvantage of an individual resulting from a disorder or impairment that limits or prevents certain normal roles expected from such individual"*** (European Charter of Sport for All: persons with disabilities, 1996). This is another term that is not used frequently or correctly in kinanthropology, special education or in the Czech social or health-care system.

In our practical contexts, the following terms are comprehensible and ethically acceptable: ***individuals (persons) with visual impairment*** and the ***visually impaired*** (VI). These terms will be used throughout the text.

One last comment to conclude the issue of terminology. In an effort to achieve absolute terminological "purity" the core of the issue and particularly the otherwise visually equipped person should not be left behind, which unfortunately frequently happens in practice. However, we are aware of the fact that not all terminological issues have been or could have been covered. If some of our thoughts, observations, comments and quotations of some authors encouraged your interest, our objective has been achieved.

2 /

Type of impairment and its categorisation

Ladislav Bláha

With respect to the specifics of impairment in each individual, the type and degree of impaired visual abilities must be characterized. Visual impairment can be specified from various perspectives, the core ones being visual acuity, visual field, date of onset, expected development, etiology and others. The complex issue defining the severity of visual defects is thus given by various etiologies and extent of impairment. As a result, some authors try to specify the criteria leading to a system of assessing the severity of the impairment (Annex 2). A number of countries and their functional systems currently use the definition of the World Health Organization (Table 1).

Table 1. Degrees of visual impairment according to the WHO

Degree (class)	Functional ability and visual impairment categories
Moderate visual impairment	visual acuity with the best possible correction: maximum worse than 6/18 (0.30) – minimum equal to or better than 6/60 (0.10); 3/10–1/10, visual impairment category 1
Severe visual impairment	visual acuity with the best possible correction: maximum worse than 6/60 (0.10) – minimum equal to or better than 3/60 (0.05); 1/10–10/20, visual impairment category 2
Extreme visual impairment	a) visual acuity with the best possible correction: maximum worse than 3/60 (0.05) – minimum equal to or better than 1/60 (0.02); 1/20–1/50, visual impairment category 3 b) concentric limitation of the visual field of both eyes under 20 degrees, or of one functional eye under 45 degrees
Practical blindness	visual acuity with the best possible correction 1/60 (0.02), 1/50 to light perception or limitation of the visual field around central fixation although central acuity is not affected, visual impairment category 4
Complete blindness	loss of vision from complete loss of light perception to retained light perception with faulty light projection, visual impairment category 5

Source: Visual impairment classification according to the WHO (Czech Blind United, Czech Republic, 2010).

Some scientific disciplines prefer a different type of classification that combines specific types of diseases (Table 2).

Table 2. Visual impairment and brief definitions

Identification	Other specification	Degree of visual impairment
Blind persons	Real blindness	Decrease in central visual acuity under 1/60 – light perception. Binocular visual field 5° and less even without disruption of central fixation.
	PPractical blindness	Decrease in central visual acuity less than 3/60 to 1/60 inclusive. Binocular visual field smaller than 10° but bigger than 5° around central fixation.
Persons with remaining vision	Previously identified as partially sighted or severely visually impaired	Between blind and visually impaired
Blind persons	Mild	Decrease in central visual acuity up to 6/60.
	Severe	Decrease in central visual acuity less than 6/60 to 3/60.
Persons with binocular vision disorders		The retinas of both eyes do not provide equal images on identical places to ensure spatial perception and stereoscopic depth vision. Disorders of analytic-synthetic function, localization and depth vision.

Note: With respect to Ludíková clasification (2005, 198).

These approaches classify the types of visual impairment according to the cause of such visual impairment: functional defect (amblyopic and squint-eyed persons) or organ defect (Štréblová, 2002). We should also mention the specifics used in resocialization and education of late blinded persons and persons with combined impairment. Functional systems of health-care, social security, general education, physical education and sport maintain their own specifics of defining visual impairment and taking care of persons with visual impairment. A unifying line is given by the World Health Organization (WHO – 10^{th} revision of the International Statistical Classification of Diseases and Related Health Problems, Chapter 7: “Diseases of the eye and adnexa”). Generally it can be stated that visual impairment is ranked among significant issues with an impact on economy and the development of the society, which frequently decreases the quality of life of impaired individuals. According to WHO estimates, 161 million people were affected by visual impairment in 2002, of which 37 million people were blind.

Insufficient perception by the visual analyser is classified by means of international universal regulations and scales in optometry and ophthalmology systems. These scales must comply with the requirements of specialists and understanding of the lay public. At the same time, the classifications must cover various types of visual impairment.

In line with Lieberman and Cowart (1996, 138) “visual handicap” is defined according to ***“angular (visual) acuity”.*** This value is expressed by means of vision defined as a fraction, i.e. the ratio between the distance at which an impaired individual can read a symbol compared with a healthy individual. The principle of reading letters or characters at a distance is also used by a similar method (used in biomedicine and some social disciplines): the ***Snellen scale*** (see e.g. Office of Special Education and Rehabilitation Services – Table 3) (Lieberman, 2005).

Table 3. Degrees of visual impairment according to the OSERS

Degree (class)	Equivalent	Functional ability
Certified blind	Legal blindness	vision 6/60 (20/200), able to see at a distance of 6m (20 feet) what a healthy eye is able to see at a distance of 60m (200 feet)
Travel vision	Travel vision	vision 1.5–3/60 (5–10/200)
Motion perception	Motion perception	vision 0.9-1.5/60 (3-5/200)
Light perception	Light perception	vision less than 0.9/60 (less than 3/200) able to see a strong light, unable to detect arm movement at a distance of 0.9m (3 feet)
Total (complete) blindness	Total blindness	unable to recognize a strong light shining directly to the eyes

Note: The Office of Special Education and Rehabilitation Services does not use the degree (class) of "motion perception".

Obviously, defining visual impairment just by vision acuity and visual field extent is insufficient. It is desirable to determine more objective diagnostics, for example by obtaining data on other visual functions such as:

- contrast sensitivity (photophobia, night blindness),
- ability to distinguish colours (colour blindness),
- depth perception,
- ability to localize,
- ability to fix objects,
- ability to watch objects in motion, etc.

Similarly, it is necessary to respect other approaches to the classification or typology of visual impairment required by various scientific disciplines (Keblová, 1996, 2001; Štréblová, 2002 and others).

For the purposes of organizing physical activities the above mentioned classification methods do not appear suitable because the narrowly defined degrees (classes) of impairment would limit the number of participants. The ***IBSA (International Blind Sport Federation)*** has an own category system and widens the limits for competitions and respects various degrees of impairment where necessary. This classification (Table 4.) follows the previous classification (Table 5.) and acknowledges three categories of impairment, initially marked as A, B, C (Shephard, 1990; Sherrill, 1998), nowadays as B1, B2, B3 (Lieberman, 2005). The classification degree is assessed on the better eye with optimum correction (i.e. all competitors using contact lenses or glasses must wear them during classification, irrespective of whether they intend to wear them during the competition or not).

Table 4. Current categories of visual impairment according to IBSA

Degree (class)	Functional ability
Class I. (B_1	Visual acuity weaker than LogMAR 2.60.
Class II. (B2	Visual acuity between LogMAR 1.50 and 2.60 (inclusive) and/or visual field constricted to less than 10 degrees.
Class III. (B3	Visual acuity between LogMAR 1.40 and 1 (inclusive) and/or visual field constricted to less than 40 degrees.

Visual impairment classification (ČSZPS, 2013)

Table 5. Categories of visual impairment according to IBSA valid until 2012

Degree (class)	Functional ability
Class I. (B_1)	Defined as zero light perception (total blindness) to inability to recognize an object or its contours.
Class II. (B2)	Defined as ability to recognize an object of visual acuity up to 2/60 (6.7/200), or visual field constricted to 5 degrees.
Class III. (B3)	Visual acuity 2/60 to 6/60 (6.7/200 to 20/200) or visual field constricted to 5–60 degrees.

The IBSA sports classification is acknowledged also in the Czech Republic. In our country, category IV (B4) was also introduced. This specific category is accepted in some types of domestic competitions, particularly for children and young people. This is an “open” category and involves visually impaired individuals who are no longer in the B3 category. The classification is always performed on the better eye with best correction i.e. using glasses or contact lenses irrespective of whether they are used during the competition or not (Daďová, Čichoň, Švarcová, & Potměšil, 2008). For the purposes of competitions, the examination is performed by an ophthalmologist or optometrist. The result of the examination must be recorded in the membership card of the ČSZPS (Czech Blind Sportsmen Association) and registration card kept by the Association’s secretariat. The classification of visual impairment is re-checked prior to significant competitions. In 2000 a new measure was adopted taking into account possible progression of the impairment; therefore, the classification now specifies whether the impairment is permanent or whether re-classification might be required in the future. Currently (2012) international sports competitions have international classification teams that classify all competitors from the whole world in the respective disciplines. This ensures a unified classification procedure.

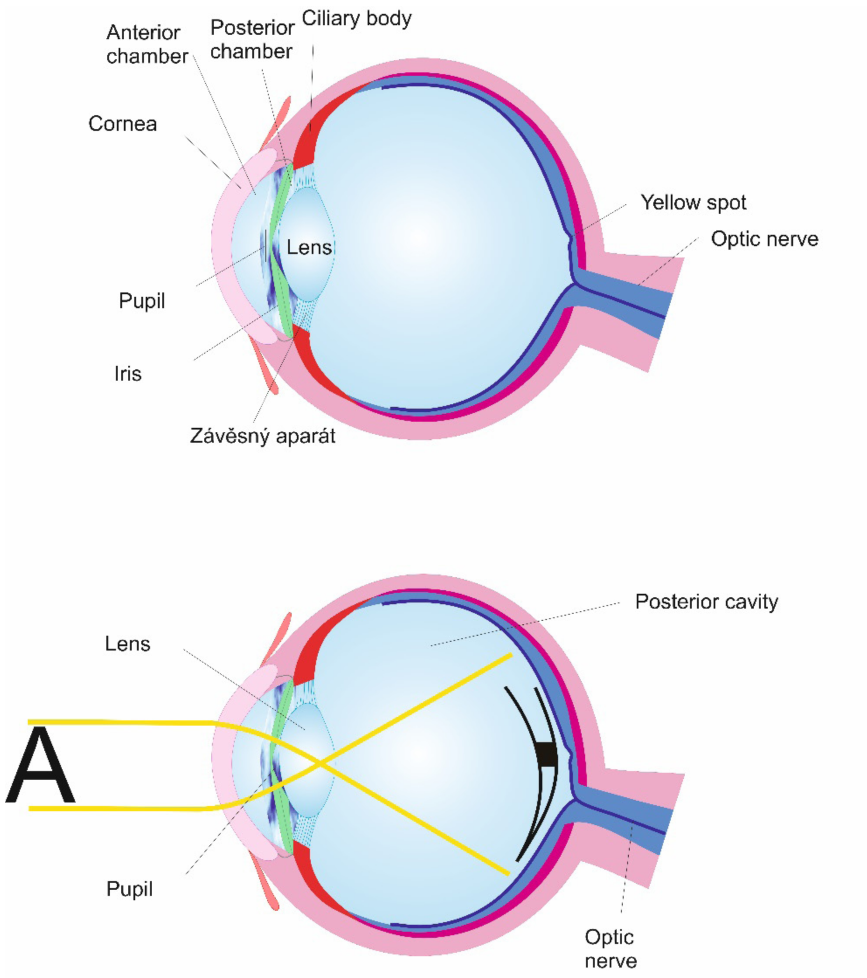
3 /

Vision

Zbyněk Janečka

The eye is often compared to a photographic instrument. The lens is represented by the optical system of the eye, the aperture by the iris with the changing pupil, and the sensitive film layer by the retina. Focusing on various objects at various distances is ensured by the ciliary muscle by affecting the refractive power of the lens. Objects located in the outside environment produced an inverted, real and lessened image on the retina. The image is relatively precise despite the fact that the components of the optical system have numerous deficiencies from a physical and optical perspective. The retina is 24 mm from the outer edge of the cornea and lies in the focal point of parallel beams that enter the eye in case of relaxed accommodation.

Figure 1. Diagram of the human eye and simplified principle of projection on the retina.



3.1 Vision (visual acuity)

Assessment of distance vision

The basis for determining the **vision** is the resolution ability of the eye. Resolution is the ability of the eye to identify two spatially separated objects as two. This is identified as **minimum separabile**. The image of the two objects on the retina must be separated by at least one unlighted cone, which represents the space between the two lighted cones. In the foveal area of the retina the diameter of the cones is between 2–2.5 µm. Respecting the principles of geometric optics it can be calculated that one minute of arc in the space of the object corresponds to a length of 5 µm on the retina. This means that a single cone images an object of an angular size of 0.5–0.4´. This size is also a measure of the **minimum angle of resolution** (MAR). This quantity needs to be analysed in determining vision. Vision is then a reciprocal value of MAR expressed in minutes of arc: $V = 1/MAR_{(min)}$. If MAR = 0.5 then V = 2. Recently the obsolete Snellen type charts have been reviewed and replaced with "logMAR charts (**logarithm of minimum angle of resolution**)" (Kraus et al., 1997). In expressing vision using the Snellen fraction (e.g. 6/24) the numerator represents the distance at which a proband is tested, whereas the denominator represents the distance from which the critical detail of the optotypes of this line forms an angle of 1 minute of arc. The reference value is derived from correct determination of an angle of 1 minute of arc from a specified distance (e.g. 6 m). In this situation V = 6/6 and logMAR = 0. An inverted value of the Snellen fraction equals the size of MAR. Vision is also frequently expressed by means of a decimal conversion of these fractions. As a matter of fact, distance vision is represented by vision at a distance close to infinity. However, the most frequently used examination distances (6.5 or 4 m) are not in infinity and require some accommodation effort. For the purposes of precise determination of correction, the refraction correction of 0.25 D must be subtracted from the identified spherical component. The basis for determining vision is identifying the smallest angle of vision of a critical detail of an optotype that the examined person is able to see. This is also the definition of the threshold stimulus. The definition expresses the size of MAR that the examined person answers correctly in 50% and incorrectly in 50% (after correction of random correct answers). In determining vision using the whole-line method, MAR must be answered correctly in 100%. If this table method is complemented with "log MAR", the whole-line result can be used to assess threshold vision, which is approximately by two normalized lines higher, i.e. about 58%. In the case of the Snellen optotype charts, which do not have equidistant line intervals, obviously this estimate does not apply (Kraus et al., 1997). If a person is unable to read the largest optotypes on the table, the distance between the eye and the table must be shortened to as little as 0.5 m. Practical blindness is a condition when a person with visual difficulties is affected by decreased vision and is unable to use vision in an active way. This typically occurs for V = 3/60–2/60. Vision of 6/60–3/60 is considered legal blindness. A lower degree of vision is defined by perception of a moving arm in front of the eye and another lower degree by differentiating light and dark – light perception. This low degree of vision must be complemented with data on light projection from various places of the visual field. Another lower degree is the presence of light perception without any correct projection. Only an eye without light perception is identified as amaurotic; V = 0 (Řehák et al., 1989). Distance vision is examined using optotypes. The Snellen charts consist of letters or numerals. The Plűger hooks are variously oriented letters E. The Landolt rings have the shape of the letter C disconnected in various quadrants. Children who cannot read are tested by means of picture optotypes. The following figures show some examples.

Figure 2. Optotype table of logMAR type with Landolt rings. Adapted from (Hamadová, Květoňová, Nováková, 2007, 16), in review (Hrbáčková, 2013)

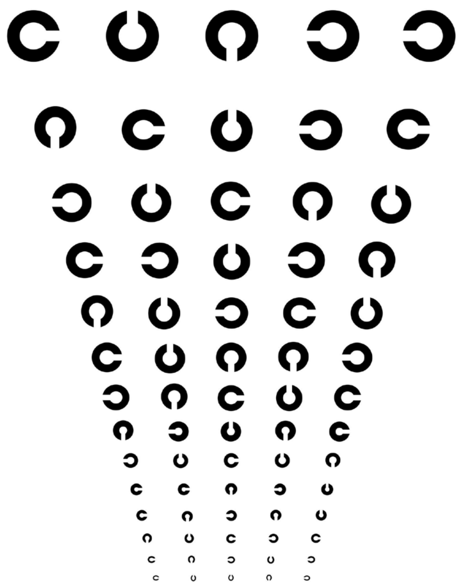


Figure 3. Optotype table of Snellen type with letters or numerals. Adapted from (Hamadová, Květoňová, Nováková, 2007, 15), in review (Hrbáčková, 2013)

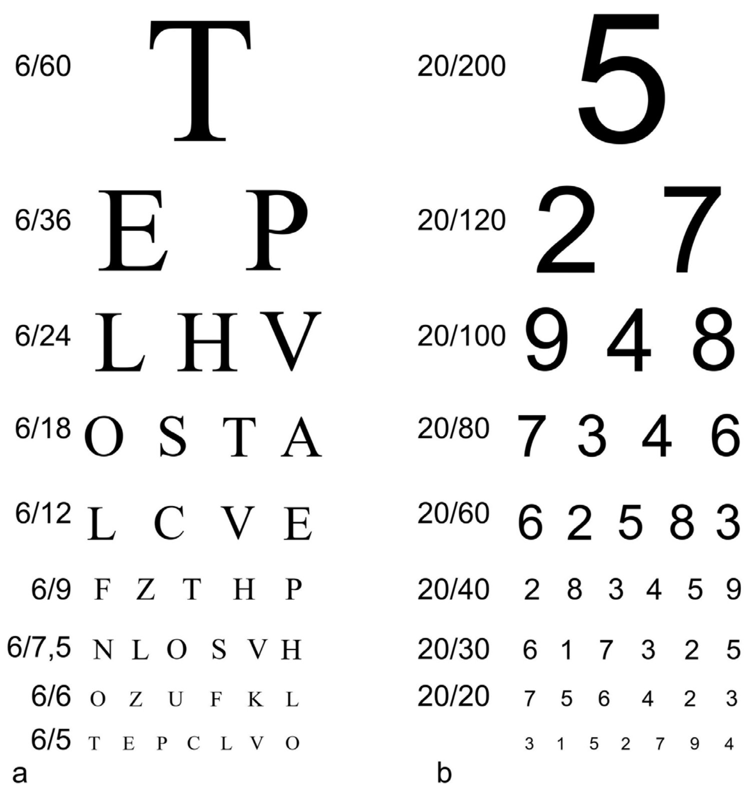
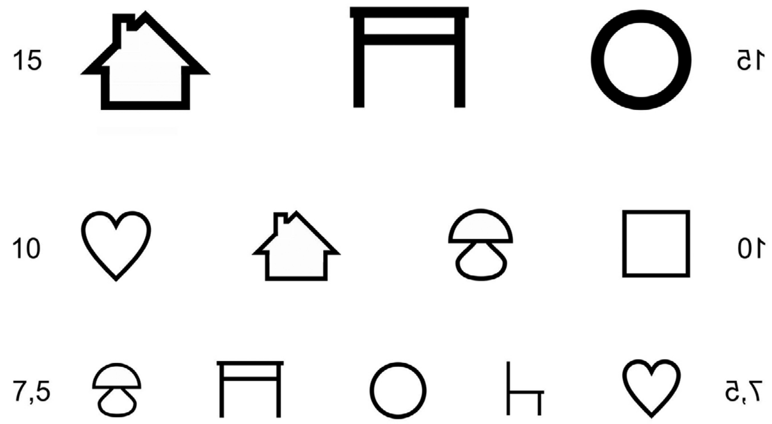


Figure 4. Optotypes for children. Adapted from (Hamadová, Květoňová, Nováková, 2007, 16), in review (Hrbáčková, 2013)



Assessment of close vision

In testing close vision the same conditions as for distance vision might be used, only the angular size of the optotypes must be adjusted with respect to the examination distance of 30 or 40 centimetres. Such charts are commercially available (Topkon, Oculus, & Rosenbaum etc.) and mostly contain the Landolt rings. The main objective of close vision examination is to assess the probands' ability to read and perform work with fine details. For this purpose charts with continuous text are used, where the paragraphs are printed in various sizes and identified with numbers (e.g. Jäger charts) (Kraus et al., 1997, 41). A similar principle is used by diagnostic charts for close vision examination type Zeiss, LH optotypes with numbers or symbols.

Close vision is examined at a distance of 30 cm. The following table shows an example of the Jäger charts.

Table 6. Example of a chart for close vision assessment

The princess with the golden star
No. 12
A merchant climbed a hill and looked around
No. 11
Ships from all over the world were moored in the port
No. 10
In each village school there were a lot of children from
No. 9

Because of the roaring engines at the start of the rally we could not hear
No. 8
Children like flying a kite in autumn
No. 7
This year shop keepers were very early with St, Nicholas and Christmas goods.
No. 6

Visual field

According to Moravcová (2004), the visual field represents a sum of all dots that are projected on the retina with motionless eyeball looking forward. In a physiological condition the visual field reaches 90° temporally and 60° nasally. Upper reach is 60°, lower reach is 70°. The visual field of both eyes overlap by about 60° around the fixation point. This enables stereoscopic spatial vision. Autrata and Vančurová (Autrata & Vančurová, 2002, 93) claim that "binocular vision is co-supported by three functional components of the visual organ. The optical component moderates the flow of beams through the refractive environment of the eye so that the retina receives an acute image. The motor component sets the eyeballs into a position so that the image is projected in the optical centres of both eyes. The task of the sensory component is to lead the excitations from the retinas of both eyes into the cortical centres. There the excitations merge and we perceive them".

Vision is mediated by two eyes; however, both retinas function as a single organ under physiological conditions. Correct functioning of binocular vision is subject to congenital coordination of eye movements in all directions, identical (corresponding) positions of the retinas of both eyes and eventually to fusion of the sensory impulses from both eyes. Disparate (non-corresponding) retinas positioned a short distance apart allow spatial vision (Panum's space) (Syka, Oldřich, & Vrabec, 1981).

Degrees of quality of binocular vision:

- **Simultaneous vision** is the ability to see the surrounding environment by each eye separately.
- **Fusion** is the ability to perceive the image of the surrounding environment by both eyes as a single perception.
- **Stereoscopic vision** is the ability not only to perceive the surrounding environment as a single image but also three-dimensionally, i.e. with acuity depth.

Peripheral vision (especially rod vision) allows spatial orientation and adaptation to low illumination. It is colour-blind. From the central fovea (fovea centralis retinae) towards the periphery there are fewer cones and more rods. In the periphery of the retina there are only rods (approximately 120 million in the retina). Peripheral vision is scotopic and is characterized by a central scotoma in case of complete adaptation in night vision. Adaptation to dark does not engage cones, as they are situated in the centre of the visual field. Orientation in a space depends on the extent of visual perception, i.e. on the functional visual field. As a result of some types of eye diseases the visual field can be limited in the periphery, central area or overall. Spatial vision is very significant; therefore, a person with a concentrically constrained visual field in the better eye under 10° even in case of normal central vision 6/6 = 1.0 is legally considered practically blind, so is a person with central vision in the better eye equal to or worse than 3/60 (Syka, Oldřich, & Vrabec, 1981).

Oculomotor skills

The movement of the eyeball is ensured by six striated muscles. These muscles ensure looking up (elevation) and down (depression), left (nasal adduction) and right (temporal abduction) and circular eye movements (intorsion and extorsion) in the case of the right eye.

Eye movements can be classified as follows:

1. Involuntary – automatic
   a) conjugated (version)
   b) disjunctive (vergence)
   c) saccadic eye movements
   d) smooth watching movements
   ad a) Conjugated movements represent a mutual movement of both eyes when watching an object that moves right or left in the visual field.
   ad b) Disjunctive movement is performed when watching a movement in the sagittal plane. Again, the eyes move at the same time but in the opposite direction.

In case of a symmetry disorder of the eyes movements, squint-eye (strabismus) occurs.

   ad c) Saccades ensure quick directing of the most acute vision spot on the retina to the contrast object moving in the visual field. These movements are exceptionally fast; their angular speed reaches around 700°/s.
   ad d) Smooth watching movements ensure that the object is maintained in the visual field, which is then captured by the saccade provided that its speed does not exceed 25–30°/s. Saccadic and smooth watching movements can be observed in the so-called optokinetic nystagmus.
2. Volitional

Volitional eye movements are always conjugated or disjunctive with one exception. In clinical medicine they are identified as looking (Králíček, 2004).

Colour perception

Colour perception is another factor that characterizes vision quality. Perception of colours is an ability of the eye to distinguish various lengths of electromagnetic waves and perceive them as colours.

Colour perception is a complex psychological process. A human is able to perceive about 150 colours in the visible light spectrum. In total, a human is able to distinguish over 2,000 shades (Autrata & Vančurová, 2002). The vast numbers of colours are made of a combination of the three basic colours – blue, green and red.

Kraus et al. (1997) state that colour perception testing is performed in the range of 380–760 nm. The following three factors are crucial:

- colour tone
- colour intensity,
- brightness.

According to Moravcová (2004) a colour perception originates by excitation of the retina by the energy of visible light of various wavelengths. Colour vision is ensured by means of cones that contain visual photopigment of three various types (**S, M** and **L**). Each of them reacts to a different wavelength of sunlight. **S** (short wave) is most sensitive to the blue colour, **M** (middle wave) to the green colour and **L** (long wave) to the red colour. According to the trichromatic theory, the colour code is defined by the mutual ratio of generator potentials on the mentioned three types of cones. Their specific combination can result in any colour in the sunlight spectrum.

Colour perception examination is performed on colour samplers. According to Kraus (1997), an example could be the Farnsworth and Munsell 100-hue test, which contains 85 coloured discs positioned in four sections, or the internationally acknowledged Lanthony 40-hue test with only 40 discs.

Sensitivity to contrast

The distinguishing ability of the eye is defined by the level of vision. Kraus et al. (1997) states that the assessment of vision requires a high degree of contrast (0.85 and higher). The resolving power of the eye is directly proportional to the level of contrast. Contrast is defined by subjective assessment of the difference in brightness of two surfaces seen simultaneously in the visual field of both eyes or gradually assessed unequal stimuli (Moravcová, 2004). Decreasing brightness (i.e. the amount of reflected or emitted light energy) causes a decrease in the resolving power of the eye. As mentioned above, this is conditioned by physiological mechanisms of receiving light of various wavelengths and is caused by a transition from photopic to mesopic and eventually scotopic vision. A change in brightness also induces a reaction of muscle fibres of m. dilatator papillae, i.e. by mydriasis (pupillary dilation) in case of decreased brightness or miosis (pupillary contraction) in case of increased brightness.

The most widely used examination procedure is the VCTS (visual contrast test system). These circular charts of 7.45 cm diameter have five lines and nine columns. The level of brightness should be between 69–240 cd/m^2.

Adaptation to darkness and dazzling

Considering the wide wavelength spectrum, the eye is able to perceive only a small section of electromagnetic waves from 380 to 780 nanometres /nm/. An eye adapted to light perceives various wavelengths as colours – photopic vision (daily colour vision). Photopic vision is mediated by cones concentrated in the central area. This is the area of the most acute vision. Scotopic vision (low light) is peripheral vision ensured by rods. Scotopic vision is colour-blind with an approximate vision value of 1/60; on the other hand, scotopic vision allows orientation under significantly low-light conditions. In case of a lower degree of brightness we speak of mesopic vision, which is considerably inaccurate and involves both rods and cones. The ability to orientate is worse and vision is less accurate compared with a higher degree of brightness (Syka, Oldřich, & Vrabec, 1981).

Adaptation is the ability of the eye to accommodate to various light conditions. The functional extent of the eye is exceptionally large. The eye is still able to see in the darkest night although the ratio of the illumination compared with a bright sunny day is 1:100 billion. The time that the eye needs to adapt is proportional to the differences in light intensities (Syka, Oldřich, & Vrabec, 1981). Adaptation to light occurs immediately. Adaptation to darkness is longer and has two stages (Trojan et al., 1999). Quick adaptation involving the pupil and cone adaptation, which takes about 5 minutes; after five minutes slow adaptation begins, this is a matter of rods only. After about 30 minutes the eye is fully adapted to low illumination (scotopic vision). Darkness to light adaptation takes only 0.15 s; full adaptation is achieved after 6 minutes (Syka, Oldřich, & Vrabec, 1981).

3.2 Visual defects

A visual defect influences the development of an individual with visual impairment depending on the nature and seriousness of the defect, stage of life during which the defect occurred and its etiology. Each visual defect has specific features that influence the development of visually impaired persons in their future lives. Damages and disorders can affect most parts of the vision system, through which our visual functions are effectuated.

Visual difficulties in persons with VI of all degrees of impairment present a significant complication in physical education, sport as well as physical activity recreation. For this reason we need to know:

- How a child or adult with VI sees.
- What are the medical risks associated with a specific visual defect and potential dangers ensuing from inappropriate or inappropriately performed activities.
- Whether a visual defect or impairment is stationary or whether there is a risk of progression.

For this reason it is necessary to perform comprehensive diagnostics of a visually impaired pupil. This results in defined indications and contraindications in the area of physical activity for various visual defects. Visual defects can be classified in two categories:

a) without a risk of deterioration of or damage to vision,
b) with a risk of deterioration of or damage to vision,
ad a) This group involves visual defects and diseases that can significantly limit physical activity but have no negative effects on the deterioration of visual functions. These include e.g. limitation of the visual field, ability to distinguish colours, limited spatial perception, worse visual acuity, etc.
ad b) This group involves disorders and diseases, where inappropriate physical activity could lead to an irreversible damage to the eye. However, the physical activity limitations need not be absolute. This can affect only certain types and groups of activities. The risk of damage to the eye can also be eliminated

by activities that considerably limit the risk of eye damage. These activities are performed at a slow pace in a lying, upright sitting or knees bent position.

The last note concerns progressive defects. Most of us have a tendency to classify a child with VI into a specific category. In case the defect gradually worsens and this fact is neglected, after a certain time the visual capabilities of such individual might be underestimated. This could lead to an injury. Therefore, these cases have increased attention and their diagnostics is regularly referred to.

3.2.1 Refraction defects

The association between the refractive power of the optical system of the eye and the distance of the eye axis, or more precisely the distance between the outer edge of the cornea from the retina, is identified as eye refraction (Syka, Oldřich, & Vrabec, 1981). The condition of eye refraction depends on the degree of visual acuity. Visual acuity is the ability of visual differentiation, where close and distance vision is measured. Any positive or negative deviations from refraction define the degree of visual impairment. A condition when parallel beams are refracted by the eye so that they converge directly at the retina is called emetropia (refractive power corresponds with eye length). A condition when beams converge off the retina is called ametropia (refractive power of the eye is bigger or smaller than the corresponding eye length) (Kraus et al., 1997). The degree of refraction and the strength of glasses needed to correct refraction defects are measured by dioptres (D). One dioptre corresponds to refractive power of a lens, whose image focal length in air is one metre.

An ametropic eye has one of the following defects:

- hypermetropia (long-sightedness),
- myopia (short-sightedness),
- astigmatism.

3.2.1.1 Long-sightedness (hypermetropia)

Long-sightedness (hypermetropia) is caused by an imbalance between the length of the eyeball and refractive power of the eye. In case of hypermetropia the eyeball is too short with respect to its refractive power. Therefore, parallel beams from a more distant point reach the retina before they are concentrated in the focal point. The focal point lies behind the retina. This type of defect is called axial hypermetropia. Usually it does not exceed +6 D. In pathological cases (tumour, microphtalmus, oedema) hypermetropia can achieve +20 D or even more.

Curvatory hypermetropia is caused by insufficient curvature of one of the refractory functions. Usually the cornea is insufficiently arched. A flat lens is a rare cause of curvatory hypermetropia.

Index hypermetropia is caused by a decrease in the refractive index of the lens tissue.

A surgical removal of cataract results in aphakia. This type of hypermetropia is characterized by +10 to +12 D.