TECHNICAL REPORT

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Information Technology — Biometrics — Guide on designing accessible and inclusive biometric systems

Technologies de l'information — Biométrie — Guide sur la conception des systèmes biométriques accessibles et inclusifs

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT), see the following URL: Foreword — Supplementary information.

The committee responsible for this document is ISO/IEC JTC 1, *Information Technology*, Subcommittee SC 37, *Biometrics*.

Introduction

This Technical Report provides support for the further development of ISO/IEC biometrics international standards in the context of cross-jurisdictional and societal applications of biometrics, including standardization of both existing and future technologies.

ISO/IEC/TR 24714-1:2008 lays down the principle that inclusive designs of biometric systems are ones that as many subjects within the target population as is reasonably possible can use the systems effectively and with minimum discomfort. This Technical Report offers guidance in the dialogue between writers of system specifications for biometric systems and the developers of biometric systems, in reaching a common understanding of the target population and agreement of what is reasonably possible. This Technical Report aims to aid the procurement process of biometric systems, provide a means of acceptance of inclusive design, and ultimately improve accessibility of biometric systems.

Central to a common understanding of target populations is an agreed taxonomy. This Technical Report establishes taxonomy based upon a person's inability to perform a function. This enables a writer of a system specification for a biometric system to specify those categories that must be handled by the primary biometric system and those categories that would be required to use the exception handling process. Conversely the taxonomy enables biometric system suppliers to specify which parts of the population they have accommodated for in their designs.

Agreed quantification of the target population and how accessibility and inclusivity is to be achieved enables acceptance testing to be devised.

Information Technology — Biometrics — Guide on designing accessible and inclusive biometric systems

1 Scope

Procurements of biometric systems often stipulate requirements for the systems to be inclusive and make provision for exception handling.

This Technical Report provides guidance for biometric system design and procurement to handle the range of accessibility and usability issues. This report will build upon the generic guidance in ISO/IEC/TR 24714-1, *Information technology — Biometrics — Jurisdictional and societal considerations for commercial applications – Part 1: General guidance*.

The biometric modalities addressed in this technical report include those described in the ISO/IEC 19794, (All parts), *Information Technology — Biometric data interchange formats:*

— Finger

— Face

— Iris

— Signature

— Vascular

— Hand-geometry

— Voice

2 Accessible and inclusive design taxonomy

The taxonomy used by this Technical Report reflects that described in ISO/IEC/TR 29138-1.This Technical Report provides examples of good practice for particular biometric modalities against the taxonomy, resulting in guidelines for inclusive design for the widest range of the population. The Technical Report can also help in selecting suitable biometric modality solutions when designing solutions with a particular population from the taxonomy descriptions.

There is a basic principle of designing biometric systems in a way that they can be used effectively and with minimum discomfort by the whole target population. There is also the need of reaching a common understanding of the target population and an agreement of what is reasonably possible. This brings the requirement of designing biometric systems following the best possible guidance to create systems that are accessible. Accessibility problems of biometrics systems are not limited to disabled people. Other groups may be affected due to occupational constraints, medical procedures and religious/cultural issues.

A person may not be aware of any issues of them using a biometric system until at the point of use.

Biometric systems are not familiar to all, and even then may not be regularly used. Therefore inclusive design must be based upon a lack of familiarity.

Considering all these scenarios, the following taxonomy can be considered. Each of the categories and subcategories in this taxonomy will be detailed in subsequent clauses of this Technical Report.

— (Inability to) Perceive visual information

  — People who are unable to perceive any visual information.

  - People who have difficulty in perceiving visual information.
- (Inability to) Perceive auditory information
  - People who are unable to perceive any auditory information.
  - People who have difficulty in perceiving auditory information.
- (Inability to) Perform motor actions
  - People who are unable to walk unaided.
  - People who are unable to stand.
  - People who are unable to pitch, or yaw, or rotate head, or keep stationary.
  - People who are unable to raise and/or rotate arms/hands.
- (Inability to) Present physiological attribute
  - Unable to present the specified hand(s).
  - Unable to present specified finger(s) and/or palm(s).
  - Unable to present the specified eye(s) as attribute or as landmark.
  - People who are unable to present physical attribute within the specified field of the sensor.
  - Unable to present specified auditory input.
- (Inability to) Apply instructions due to mental impairment
  - People with cognitive or learning difficulties.
  - Where interaction and/or responses from system are counter intuition or familiarity.
- (Inability to) Follow guidance due to cultural discrepancies
  - People with language differences.

A description of each sub-category is provided in the form of examples, rather than any medical condition. Associated with each category are references that contain guidance to improve particular accessibility. In addition specific guidance for biometric systems is offered if this is not contained in other reference documents.

Depending on the disability, the use of certain biometric modalities can be inappropriate and alternatives should be in place.

3 Generic problems and recommendations

3.1 Generic problems

- Difficulty in positioning to see information or device if not in line of sight.

3.2 Recommendations

- In authentication schemes that use tokens (where the user has to claim its identity in advance), these tokens should store information about the impairment of the user, for dynamic adaptation of the system to that impairment.

3.3 Sources for addition guidance on accessibility

For the design and development of a biometric system able to be used by people with disabilities, a huge amount of standards and technical reports should also be addressed. ISO/IEC/TR 29138-2 provides an inventory of all those related standards (international and regional) that could be applicable, being some of them independent on the disability, while others focussed on a certain kind of disability.

4 (Inability to) Perceive visual information

4.1 Examples of Problems

4.1.1 People who are unable to perceive any visual information

— Cannot access information presented (only) via graphics.

— Cannot find device(s).

— Cannot tell status of visual indicators (e.g. LEDs, on screen indicators), or gain visual feedback.

— Cannot determine number, size, location of controls on touch screens or flat membrane keypads, or difficulty in locating without activating.

— Cannot align line of sight to markers.

4.1.2 People who have difficulty in perceiving visual information

— Difficulty in discriminating foreground information from background information.

— Difficulty in discriminating colours.

— Problems with glare from screens.

— Difficulty in seeing temporary presented information.

— Difficulty with insufficient ambient light.

4.2 Modality independent guidance

Clauses in ISO/TR 22411 that apply to this case are 8.2.1, 8.2.2, 8.2.5, 8.3.1, 8.3.3, 8.4.4, 8.5.1, 8.5.2, 8.5.3, 8.6, 8.7.1, 8.7.3, 8.11.1, 8.11.3, 8.12.2, 8.12.3.1, 8.12.3.2, 8.12.3.3, 8.12.6, 8.17.2, 9.2.1, and 9.2.1.3.

In addition, the following recommendations should be followed.

— Feedback to the user should not be provided only by means of visual signalling. Other feedback alternatives, such as auditory or tactile should be considered as complementary to the visual feedback.

NOTE While using colour can be a plausible solution, caution should be exercised on the choice of colours to accommodate people with colour vision deficiency.

— In authentication schemes (where the user has to claim its identity in advance) use tokens that also have information stored about the impairment of the user, and adapt dynamically the system to that impairment.

— Visually the capture device should stand out if it is attached to a terminal. The capture device should be highlighted by making it a different colour to the surrounding area, or using alternative illumination.

4.3 Additional modality specific recommendations

4.3.1 Finger

— The reader should not be flush against the rest of the terminal. This will make it more noticeable from both a visual and a tactile point of view. The device as a whole should be raised from the terminal, with the scanner area itself slightly recessed into the raised surrounding casing.

— Where multiple scans are taken in sequence, ideally the subject should be able to simply press and hold the finger in place (i.e. removing the necessity to lift and replace the finger repeatedly). If repeated removal and replacement of the finger(s) is required, then there should be a ridge around the scanner area to aid location.

— The scanner area should be recessed into the surrounding raised casing, thereby guiding the finger into the correct location.

— A tactile marking (consisting of, for example, a circular area with a different texture) in the very centre of the scanner area would allow accurate positioning of the finger, while not limiting the size of the scanner area.

— The scanner area should be lit internally. The light should only turn on when the reader is awaiting input or the light should start flashing slowly when the reader is awaiting input.

NOTE It may be of interest to read the lessons learned stated in the following two links: http://www.gao.gov/assets/300/299126.pdf and https://www.dhs.gov/xlibrary/assets/usvisit/usvisit_biometric_standards.pdf

4.3.2 Face

— The light should only turn on when the camera is awaiting input.

— For capture devices requiring precise location of the subject, audio feedback can be provided to allow interacting with the systems without the need of visual feedback (e.g. telling the user where to move for a proper alignment for best face presentation).

4.3.3 Iris

— For capture devices requiring precise location of the subject, audio feedback can be provided to allow interacting with the systems without the need of visual feedback (e.g. telling the user where to move for a proper alignment or to open more the eyelids for a better acquisition).

4.3.4 Signature

— The signing tablet should not be flush against the rest of the terminal. This will make it more noticeable from both a visual and a tactile point of view. The device as a whole should be raised from the terminal, with the signing area itself slightly recessed into the raised surrounding casing.

— When a tactile screen is used for capturing the signature, there should be high contrast in the light (or colour) intensity between the area where the signature should be placed and the rest of the screen.

— When a tactile screen is used for capturing the signature and the area to capture the signature does not occupy the whole screen, an audio feedback should be provided when the signing device (i.e. stylus or finger) is outside the acquisition limits.

4.3.5 Vascular and Hand Geometry

— The reader should not be flush against the rest of the terminal. This will make it more noticeable from both a visual and a tactile point of view. The device as a whole should be raised from the terminal, with the scanner area itself slightly recessed into the raised surrounding casing.

— Where multiple scans are taken in sequence, ideally the subject should be able to simply hold the hand in place (i.e. removing the necessity to lift and replace the finger repeatedly). If repeated removal and replacement of the hand(s) is required, then there should be a ridge around the scanner area to aid location.

— The scanner area should be recessed into the surrounding raised casing, thereby guiding the finger or hand into the correct location.

— Ideally, a tactile marking (consisting of, for example, a circular area with a different texture) in the very centre of the scanner area would allow accurate positioning of the finger or hand, while at the same time not limiting the size of the scanner area.

4.3.6 Voice

— The level of directionality of the microphone should be low enough to allow acquiring the sound from the biometric capture subject even if the subject is unable to face the sensor properly due to visual impairment..

5 (Inability to) Perceive auditory information

5.1 Examples of Problems

5.1.1 People who are unable to perceive any auditory information

— Cannot hear information presented through speech.

— Cannot hear information presented through tones.

— Cannot operate devices via voice activation only.

— Difficulty in repeatability of voice inflections for voice recognition.

— Require guide or personal assistant.

5.1.2 People who have difficulty in perceiving auditory information

— Difficulties with certain frequencies.

— Difficulties with background noise interfering with auditory information.

— Speech is too fast.

— Difficulty in hearing audio information only once.

— Difficulty in discriminating sounds.

5.2 Modality independent recommendations

Clauses in ISO/TR 22411 that apply to this case are 8.2.3, 8.2.4, 8.7.1, 8.9, 8.10, 8.12.6, 8.20.1, and 8.20.2.

In addition, the following recommendations should be followed.

— The system should not use auditory as the sole mechanism for communicating information.

— The system should provide visual or vibration feedback to show when the acquisition has taken place, and about the result of the whole process.

— Lighting signalling should be turned on when the sensor is awaiting input.

— In authentication schemes (where the user has to claim its identity in advance) use tokens that also have information stored about the impairment of the user, and adapt dynamically the system to that impairment.

5.3 Additional modality specific recommendations

5.3.1 Iris

— For capture devices that have fixed focal length, requiring precise location of the subject, visual feedback can be provided to allow interacting with the systems without the need of auditory feedback (e.g. showing arrows to tell the user where to move for a proper alignment or to open more the eyelids for a better acquisition).

5.3.2 Signature

— When a tactile screen is used for capturing the signature and the area to capture the signature does not occupy the whole screen, an audio feedback should be provided when the signing device (i.e. stylus or finger) is outside the acquisition limits.

5.3.3 Voice

— Speech may be affected due to loss of hearing resulting in difficulty in using voice recognition systems.

— Use of Voice may be an inappropriate biometric measure and alternatives may need to be in place.

6 (Inability to) Perform motor actions

6.1 Examples of Problems

6.1.1 People who are unable to walk unaided

— Restricted space to accommodate a wheelchair or other support equipment.

— Difficulty with devices requiring extended reach.

— Difficulty with devices requiring the use of both upper limbs at the same time.

— Difficulty in operating products designed for a specific hand.

6.1.2 People who are unable to stand

— Difficulty with devices requiring extended reach.

— Difficulty in maintaining a steady pose.

— Require guide or personal assistant.

6.1.3 People who are unable to pitch, or yaw, or rotate head, or keep stationary

— Not being able to align correctly in an iris or face capture device.

— Not being able to provide a steady biometric sample.

6.1.4 People who are unable to raise and/or rotate arms/hands

— Difficulty with devices requiring extended reach.

— Difficulty in manoeuvring limb(s).

— Difficulty in grasping.

— Difficulty in twisting the wrist(s).

— Difficulty in quick repetition of the initial movement.

6.1.5 People who are unable to present physical attribute within the specified field of the sensor

— Devices and/or instructions at an inappropriate height in relation to own physical height.

— Difficulty with restricted space.

6.2 Modality independent recommendations

Clauses in ISO/TR 22411 that apply to this case are 8.3.1, 8.3.3, and 8.12.3.1.

In addition, the following recommendations should be followed.

— The collection of biometric data should be designed so that it can be adapted to different heights of the relevant physiological feature, either by providing separate sensors located at different heights and/or angles (e.g. standing subjects, wheelchair subjects, etc.), or by providing an adjustable sensor that can be adapted to the subject's needs.

— Acquisition environment should allow space enough (horizontally and in depth) as to allow its use by users with wheelchairs and/or having an assistant or assistance dog.

— In authentication schemes (where the subjects have to claim their identity in advance) use tokens that also have information stored about the impairment of the user, and adapt dynamically the system to that impairment.

— The area where the biometric recognition is to take place should provide some facility to allow subjects that use mobility aids, to leave them in a stable way.

— Signage should be placed to take account of standing and wheelchair using subjects.

6.3 Additional modality specific recommendations

6.3.1 Finger

— The reader should be centred on the terminal, so it is equally accessible for right- and left-handed people.

— Ideally the user should be able to simply press and hold the finger in place, while multiple scans are taken in sequence (i.e. removing the necessity to lift and replace the finger repeatedly).

— If repeated removal and replacement of the finger(s) is required then there should be a raised casing around the scanner area to allow the user to hold on to the casing.

6.3.2 Signature, Vascular and Hand Geometry

— The signing tablet or sensor should be centred on the terminal, so it is equally accessible for right- and left-handed people.

— The signing tablet or sensor, and/or surrounding terminal should have sufficient support for the wrist and/or arm.

7 (Inability to) Present physiological attribute

7.1 Examples of Problems

7.1.1 Introduction

This disability is different from the previous one, which was related to motor actions. In this case problems such as absence of the biometric property, not disability in moving it, are considered. It should be noted that it may be possible that some of the guidelines may be the same ones as for the previous section.

7.1.2 Modality independent problems

— Not able to provide the requested biometric characteristic.

7.1.3 Related to hand(s)

— Difficulty with devices requiring the use of both upper limbs at the same time.

— Difficulty in operating products designed for a specific hand.

— Difficulty where contact with body required (e.g. Fingerprint, palm print reader, or capacitive touch pad) so that artificial hands, mouth sticks, etc., cannot be used.

— Difficulty with tactile sensitivity.

— Difficulty in presenting palm(s) if unable to open or close hand(s).

7.1.4 Related to finger(s) and/or palm(s)

In addition the problems related to hands, the following ones can be considered:

— Lack of or poor fingerprints resulting from occupation.

— Lack of or poor fingerprints from medical treatment(s).

7.1.5 Related to face

— Existence of obstruction elements such as bandage or eye patches.

7.1.6 Related to eye(s)

— Existence of obstruction elements such as bandage or eye patches.

— Use of glasses with small aperture and/or low transparency prevents acquisition of a representative part of the eye.

7.1.7 Related to voice

— Cannot operate devices via voice activation only.

— Difficulty in repeatability of voice inflections for voice recognition.

7.2 Modality independent recommendations

Clauses in ISO/TR 22411 that apply to this case are 8.2.5, 8.3.1, 8.3.3, 8.12.3.1, and 8.12.3.3.

In addition to such recommendations and to the recommendations provided in Clause 6 (both at modality independent level and modality specific level), the following recommendations should be followed (this is also applicable to 7.3).

— Readers, cameras, and microphones should either cover sufficient field of capture to cover a full range of sizes of users, or be easily adjustable to enable easy adaptation for the particular user.

— Systems should provide alternatives to users to be able to be identified by means of more than one modality, being those modalities accessibility independent (i.e. face and finger, but not hand geometry and vascular (hand)).

7.3 Additional modality specific recommendations

7.3.1 Signature

— Signing area needs to be sufficiently large to accommodate all signature styles and size without restricting the user, and generating inconsistent signature/signs.

8 (Inability to) Understand and apply the instructions

8.1 Examples of Problems

8.1.1 People with cognitive or learning difficulties

— Difficulty in reading signs, labels, and instructions.

— Difficulty in understanding instructions.

— Difficulty in memorizing steps for use.

— Confused by options, and controls.

— Issues with feeling time pressured.

8.1.2 Where interaction and/or responses from system are counter to intuition or familiarity

— Difficulty in understanding a new and/or unfamiliar system.

— Difficulty in comprehension of icons and/or symbols.

— Lack of familiarity with jargon and/or technology.

— Unable to interpret the instructions for a new or unfamiliar concept.

8.2 Modality independent recommendations

Clauses in ISO/TR 22411 that apply to this case are 8.2.1, 8.2.2, 8.3.1, 8.3.3, 8.7.2, 8.8, 8.11.1, and 8.12.6.

In addition, the following recommendations should be followed:

— Whatever biometric system is to be deployed, a scenario evaluation should be done which includes a representative number of test subjects with mental impairment to analyse their level of understanding and operation of the whole system. Several sessions should be carried out (as stated in ISO/IEC 19795) separated by a minimum of 15 days to analyse the level of remembrance capability by the test subjects, paying special attention to those with mental impairment. With that information, adjust the process and the feedback provided to the subject to minimize the impact of impairment.

— In authentication schemes (where the user has to claim its identity in advance) use tokens that also have information stored about the impairment of the user, and dynamically adapt the system to that impairment.

8.3 Additional modality specific recommendations

8.3.1 Signature

— Production of signatures and secure signs require a level of either literacy or understanding of the purpose, process, and consequences of the biometric measurement.

9 (Inability to) Follow guidance due to cultural discrepancies

9.1 Examples of Problems

9.1.1 People with language differences

Lack of foreign language capability.

Unable to act on auditory instructions.

— Difficulty in reading signs, labels, and instructions.

— Difficulty in understanding instructions.

— Require interpreters.

9.2 Modality independent recommendations

Clauses in ISO/TR 22411 that apply to this case are 8.2.1, 8.2.2, 8.3.1, 8.3.3, 8.7.2, 8.8, 8.11.1, and 8.12.6.

In addition, the following recommendations should be followed:

— When designing guidance (especially when using symbols), study the meaning of them (and their equivalents) in those cultures that are relevant to the deployment. With such study, either decide for the best intersection of the potential symbols to be used, or provide several feedback alternatives for different cultures.

— In authentication schemes (where the user has to claim its identity in advance) use tokens that also have information stored about the main cultural origin of the user, and adapt dynamically the system to the cultural origin and level of the user.

9.3 Additional modality specific recommendations

9.3.1 Finger and Hand Geometry

— In order to avoid reluctance in touching surfaces, consider the user of touch-less sensors whenever the impact of such reluctance is significant.

9.3.2 Face and Iris

— For those cultures where part (or all) of the face/eyes is/are covered, privacy protection should be provided (e.g. a privacy curtain), to allow users to remove the coverage, perform the recognition, and re-place the coverage.

— For those cases where such privacy protection is not permitted or accepted, an alternative modality should be provided.

— In case of iris, consider allowing the iris recognition without prior face detection and checking. This is to be balanced with the potential risk of spoofing attacks.

9.3.3 Signature

— As different cultures sign in very different ways (some without letters, some with only capital letters, some with initials, etc.), evaluate the signature recognition solution to achieve a similar level of performance for all cultural cases that are relevant to the deployment.

9.3.4 Voice

— Repeating phrases in non-mother tongue language may not produce repeatable inflections, etc. Therefore, if a text dependent solution is deployed, allow text utterances to be in the mother tongue of the user.

Annex A
(informative)

Description of impairments

A.1 Demographics

According to the World Health Organisation [2004 & 2006 (accessed in January 2008)], the following demographics for visual and hearing impairments are recorded:

— Globally, in 2002 more than 161 million people were visually impaired, of whom 124 million people had low vision and 37 million were blind. However, refractive error as a cause of visual impairment was not included, which implies that the actual global magnitude of visual impairment is greater.

— Worldwide for each blind person, an average of 3,4 people have low vision, with country and regional variation ranging from 2,4 to 2,5.

— Visual impairment is unequally distributed across age groups. More than 82 % of all people who are blind are 50 years of age and older, although they represent only 19 % of the world's population. Due to the expected number of years lived in blindness (blind years), childhood blindness remains a significant problem, with an estimated 1,4 million blind children below age 15.

— Available studies consistently indicate that in every region of the world, and at all ages, females have a significantly higher risk of being visually impaired than males.

— Visual impairment is not distributed uniformly throughout the world. More than 90 % of the world's visually impaired live in developing countries.

A.2 Visually impaired

Individuals are registered blind if they have

— a visual acuity of less than 3/60 Snellen, or

— a visual acuity of between 3/60 and 6/60 Snellen and a considerable contraction of their field of vision, or

— a visual acuity greater than 6/60 Snellen and a field contraction covering majority of the field.

Individuals are registered as partially sighted if they have

— visual acuity of between 3/60 and 6/60 Snellen and a full field of vision, or

— a visual acuity of between 6/60 and 6/24 Snellen and a moderate contraction of their field of vision, or

— a visual acuity up to 6/18 Snellen, or even better, with a gross field defect

A.2.1 Aniridia

Aniridia is a rare congenital eye condition causing incomplete formation of the iris. This can cause loss of vision, usually affecting both eyes. In Aniridia, although not entirely absent, all that remains of the iris is a thick collar of tissue around its outer edge. The muscles that open and close the pupil are entirely missing. The appearance of a "black iris" is the result of the really enormous pupil.

A.2.2 Cataracts

A cataract is a clouding the lens. Vision becomes blurred because the cataract is like frosted glass, interfering with your sight.

A.2.3 Colour blindness

Colour blindness is the reduced ability to distinguish between certain colours or wavelengths of light. If one or more of the light detecting photoreceptor cells is faulty then colour blindness results.

A.2.4 Diabetic retinopathy

Diabetes can affect the eye in a number of ways. The most serious eye condition associated with diabetes involves the retina.

A.2.5 Glaucoma

Glaucoma is the name for a group of eye conditions in which the optic nerve is damaged at the point where it leaves the eye. In some people, the damage is caused by raised eye pressure. Others may have an eye pressure within normal limits but damage occurs because there is a weakness in the optic nerve. In most cases both factors are involved but to a varying extent.

A.2.6 Macular degeneration

Sometimes the delicate cells of the macula become damaged and stop working, and there are many different conditions which can cause this. If it occurs later in life, it is called “age-related macular degeneration”, also often known as AMD.

A.2.7 Nystagmus

Nystagmus is characterised by an involuntary movement or shake in one or both eyes. The degree of vision impairment experienced by different people with nystagmus varies from a slight blurring of vision to being registered blind.

A.2.8 Retinitis pigmentosa

Retinitis pigmentosa (RP) is the name given to a group of hereditary eye disorders. These disorders affect the retina. In RP, sight loss is gradual but progressive.

A.2.9 Other eye conditions

Other eye conditions include:

Best’s disease

- Laser surgery following cataract operations
- Charles Bonnet syndrome
- Coat’s disease
- Coloboma
- Congenital cataracts

Corneal dystrophy

- Corneal graft
- Dry eye

— Genetic eye disease

— Hemianopsia

— High degree myopia

— Macular dystrophy

— Macular Hole

Posterior vitreous detachment

— Retinal detachment

— Retinopathy of prematurity

— Stargardt's macular dystrophy

— Temporal arteritis or giant cell arteritis

— Thyroid eye disease

— Uveitis

A.3 Hearing impaired

A.3.1 Conductive loss

Conductive loss is one that effects the transmission of sound from outside the ear to the cochlea. The effect of a conductive hearing loss is to reduce the volume of sound, and amplification can be of significant benefit as once the person can hear sound, particularly speech, they can understand what is being said.

A.3.2 Sensory-neural loss

Sensory-neural loss occurs in the cochlea and/or the neural pathways to the brain. The predominant condition is associated with ageing and termed presbyacusis. However, it can result from taking certain drugs, from disease (e.g. rubella) and from excessive exposure to noise. The very important effect of this type of loss is not the reduction in sound level to the listener, but the fact that it is accompanied by distortion that makes the understanding of speech difficult. There is considerable variability in the degree of distortion in individuals, which is not necessarily related to their degree of loss.

A.3.3 Levels of deafness

It must be emphasised that hearing loss is not simply a matter of reduced sensitivity that can be overcome by increasing signal loudness. Hearing loss is usually dependant on the frequency (pitch) of the sound. For instance, presbyacuis usually leads to loss of sensitivity to higher frequencies. The hearing loss of an individual is measured by audiometry which measures the loss in decibels (dB) at different frequencies. The dBHL figures below average the loss over a range of frequencies.

People with hearing loss have the same pain and discomfort thresholds for sound as hearing people, so that when sound is amplified so that it can be heard it is quite easy for the sound to reach the discomfort or pain thresholds.

People are classified as having different levels of hearing loss. These are

— Mild Hearing Loss (25 dBHL to 40 dBHL),

— Moderate Hearing Loss (41 dBHL to 70 dBHL),

— Severe Hearing Loss (71 dBHL to 95 dBHL), and

— Profound Hearing Loss (96+ dBHL)

A.4 Physically impaired

Neuromuscular impairments include paralysis, weakness, and interference with control, via spasticity, ataxia (problems in accuracy of motor programming and coordination), and athetosis (extra, involuntary, uncontrolled and purposeless motion). Skeletal impairments include joint movement limitations, small limbs, missing limbs, or abnormal trunk size.

A.4.1 Arthritis

Arthritis means 'inflammation of the joints'. The word rheumatism is even more general, and is used to describe aches and pains in joints, bones and muscles.

A.4.2 Cerebral palsy

Cerebral palsy is where part of the brain is not working properly or has not developed. The affected area of the brain is usually one of the parts that control the muscles and certain body movements. In some people, cerebral palsy is barely noticeable. Others will be more severely affected.

A.4.3 Spinal cord injury

Depending on the extent of damage to the spinal cord, a person will be either partially or completely paralysed from the point of damage (lesion) downwards.

A.4.4 Head injury

Acquired brain injury (ABI) occurs spontaneously within the brain such as a stroke, haemorrhage or tumour. This is as opposed to Traumatic Brain Injury (TBI) which is ono-spontaneous and occurs as a result of external forces.

A.4.5 Stroke (cerebral vascular accident)

Stroke is the term used to describe the effects of an interruption of the blood supply to a localised area of the brain. This causes a number of different effects, depending on the part of the brain affected and the amount of damage to brain tissue.

A.4.6 Loss of limbs or digits

Removal of limbs may be necessary at any age as a result of various conditions, mostly peripheral vascular disease. But causes may include malignant disease, injury (trauma) or congenital deformity.

A.4.7 Parkinson's disease

Parkinson's is a progressive neurological condition affecting movements such as walking, talking, and writing. Average age of onset is around 60 years and the risk of getting Parkinson's increases with age. Younger people can also have Parkinson's and is known as "young-onset Parkinson's disease" if diagnosed in someone aged less than 40 years.

A.4.8 Multiple sclerosis (MS)

Multiple Sclerosis is the most common neurological disorder among young adults. MS is the result of damage to myelin - a protective sheath surrounding nerve fibres of the central nervous system. When myelin is damaged, this interferes with messages between the brain and other parts of the body. The onset of MS is usually between 20 and 40 years of age. It is more common in women, with a ratio of 2 men to 3 women affected. It is more common in temperate rather than tropical climates. It has a wide range of symptoms and affects every individual differently.

A.4.9 Muscular dystrophy (MD)

Muscular dystrophy is a name given to a number of conditions which have in common the breakdown of muscle fibres leading to weak and wasted muscles.

A.5 Cognitively impaired

The type of cognitive impairment can vary widely, from severe retardation to inability to remember, to the absence or impairment of specific cognitive functions (most particularly, language). Therefore, the types of functional limitations which can result also vary widely.

A.5.1 Dyslexia

Dyslexia is a difference in the brain area that deals with language. It affects the under-lying skills that are needed for learning to read, write and spell.

A.5.2 Learning disabilities

People with learning disabilities find it harder to learn, but they can do so with help from other people. Learning disabilities are sometimes known as learning difficulties, intellectual disabilities or developmental disabilities.

A.5.3 Language disabilities

Language can become disordered when parts of the brain that store words and organise sentences become damaged or disrupted. This disorder is known as aphasia or dysphasia. The types of neurological disorders that cause aphasia are usually ones that occur suddenly, such as stroke or head injury, where some degree of recovery is usual. There are a number of broad types of aphasia.

A.5.4 Dementia

The term dementia describes a group of symptoms caused by the impact of disease on the brain. Symptoms typically include problems with memory, speech and perception. Short-term memory is usually affected. Long-term memory may be retained Alzheimer's disease is the most common cause of dementia.

A.5.5 Seizure disorders

Seizures occur when nerve cells in the body misfire. Types of seizures vary. Recurrent seizures from one of many chronic processes are considered epilepsy. However, seizures are not considered to be epilepsy if they occur only once or are correctable.

A.6 Multiple Impairments

Often a person will suffer from a number of impairments and each of their needs will be different. The most commonly referenced multiple impairment is deaf blindness. This may be congenital or acquired deaf blindness

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