Cerebral Visual Impairment

TEACH CVI materials for training of teachers

“My home: stairs, people, and windows”
Drawing by S.H., a five year old girl with CVI.

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Teach CVI materials for training of teachers

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CHAPTER I

TEACH CVI MATERIALS FOR TRAINING OF TEACHERS
TEACH CVI MATERIALS FOR TRAINING OF TEACHERS

CHAPTER I: General information about CVI and practical tools
• Material produced by the TEACH CVI project members

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• Please note that information provided into this folder for teacher training is not exhaustive

• This publication reflects the views of the authors. Therefore, the Commission cannot be held responsible for any use of the information contained herein.
CHAPTER I

General information about CVI and practical tools

Part 1: Overview: General information about CVI

1. Cerebral visual impairment and the impact on learning
2. Components of the visual system
3. Possible characteristics of cerebral visual impairment
4. Visual function characteristics in children with CVI

Part 2: Guidelines

Part 3: Screening tool for detection of children with CVI

Part 4: An example of assessment program for children with CVI

Part 5: Terminology related with CVI

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Part 1: General information about CVI

1. CEREBRAL VISUAL IMPAIRMENT AND THE IMPACT ON LEARNING

Cerebral Visual Impairment (CVI) is a term used to describe visual impairment due to injury to the visual pathways and centres of the brain. CVI is a neurological impairment occurring in the presence of an intact ophthalmological system. In other words, CVI is not caused by a disorder of the eyes, but the visual systems of the brain do not consistently understand or interpret what the eyes see\(^1\),\(^2\).

CVI can be considered as one of the principal causes of visual impairment in children, especially in developed countries. The incidence of CVI is increasing due to improved medical care for children\(^3\).

The degree of visual impairment depends on the severity and location of the neurological damage as well as time of onset. The range of possible outcomes is wide, both in terms of vision and associated impairments\(^3\).

Visual outcomes can range from total blindness to mild disturbances in visual perception and frequently these children can also present with neurological disorders such as cerebral palsy, ocular impairments, cognitive impairment, epilepsy, learning disabilities, and communication difficulties\(^3\).

---


2. COMPONENTS OF THE VISUAL SYSTEM

Components of the visual system:
- Eyes and optic nerve
- Optic chiasm
- Optic tract, lateral geniculate body from the thalamus and optic radiations
- Visual cortex

When arrays of light strike the retina, visual data is transferred to the optic nerve, the visual cortex, and higher areas of the brain. The ability to study a visual scene, locate and recognize an object, move towards it, and pick it up requires a hierarchy of processes, from low- to mid- to high-level vision (figure 1).

---

4 Information shared by Roxana Czikier from the course for teacher training in Iceland, August 2016.
Low-level vision or early vision ensures the registration of light on the retina and the decoding of basic features (such as orientation, colour, size, and length) into neural responses\(^6\).

In the second level of visual processing (i.e., mid-level vision) these signals reach the cerebral cortex and the basic elements are organized into more structured components and representations (e.g., figure-ground segmentation, grouping principles, and segregation of figures from the background)\(^6,7\).

High-level vision interprets the visual input with two visual pathways: the dorsal and ventral stream. These two pathways transmit visual data from the visual cortex to other areas of the brain\(^6,7\).

![Illustration of the visual processing areas in the brain](image)

**Figure 1.** Illustration of the visual processing areas in the brain; Adapted from “Cognitive vision, its disorders and differential diagnosis in adults and children: knowing where and what things are”, by G. N. Dutton, 2003, Eye, 17(3), p. 291.
The dorsal stream or “the where system” is the visual pathway between the occipital lobes, the posterior parietal lobes, the frontal cortex, and the motor cortex. This visual stream captures a scene, gives attention to a part of this scene, facilitates switching attention from one element in the scene to another, and guides movement. This is mostly automatic and unconscious\textsuperscript{8,9}.

The visual pathway between the occipital lobes and the temporal lobes is called the ventral stream or “the what system”. It supports the process of conscious recognition of people and objects, orientation, and visual memory\textsuperscript{8,9}.

Dysfunction of the dorsal stream is thought to be more common in children than ventral stream dysfunction. Both result in a variety of problems, occurring in any combination and severity\textsuperscript{8,9}.


Dorsal stream - “Where are people / objects?”
This stream is responsible for:
- Processing of stimuli in movement
- Grasping of objects under visual control
- Visual attention

Ventral stream “What is it?”
This stream is responsible for:
- Details of objects
- Recognition of shapes
- Recognition of objects
- Recognition of human faces

It is called a 'stream' as it is a flow of information about the visual world from one place to another like water flowing in a stream.

The damage of the dorsal stream could affect:
- Getting around safely and quickly
- Picking objects up
- Bumping into things
- Using stairs
- Stepping onto pavements
- Seeing a lot of different things at the same time, e.g. finding object on a patterned carpet or something pointed out in the distance

The damage of the ventral stream could affect:
- Recognition of familiar faces
- Knowing what common everyday objects are
3. POSSIBLE CHARACTERISTICS OF CEREBRAL VISUAL IMPAIRMENT\textsuperscript{10}

**Appearance**
- Does not appear blind
- Has a blank facial expression
- Does not display visual communication skills
- Eye movements appear smooth but aimless

**Visual function**
- Varies from day to day, hour to hour
- Sporadic and limited visual attention
- Aware of distance objects but unsure what they are
- Spontaneous visual activity has a short duration
- Visual learning is tiring
- Closes eyes or looks away when listening
- Balance may improve when eyes are closed
- Looks away from people and objects
- Consistently looks to either side when looking
- When visually reaching often looks with a slight downward gaze
- Turns head away to the side when reaching, appears to use peripheral field
- Uses touch to identify objects
- Will usually track at a distance

\textsuperscript{10} Source: Rita Thompson Nov 2013 QTVI/QTMSI
Mobility skills

- May see better when traveling in a car
- Difficulties with depth perception / inaccurate reach
- Difficulties with estimating distances
- Difficulties with spatial interpretation
- Will avoid obstacles, but is unable to use vision for close work

Improved visual performance when

- Feeling secure in familiar environments with familiar people / objects
- When told what to look for and where to find it
- Objects are held close to eyes when viewing
- One object is offered at a time
- Objects are widely spaced apart on a surface
- Colour is used to assist in identification of objects or shapes
- Objects are presented on a plain highly contrasting background
- Give TIME to visually process the visual target
4. VISUAL FUNCTION CHARACTERISTICS IN CHILDREN WITH CVI

1. Difficulty focusing when looking at near objects
The focusing power of the eye needs to increase when looking at a close object. In children with CVI the focusing power can be reduced. This means the child can become tired more easily when looking at close objects.

2. Difficulty making fast eye movements
Fast eye movements are important for reading. This means the child may tend to make quick head turns when looking around a room or when reading (and doing other visual tasks). We use fast eye movements to quickly change the direction that our eyes are looking. This means the child may have difficulty following and fixating accurately on a fast moving object that has suddenly changed position.

3. Visual field
The peripheral fields extend our view almost to our shoulders on either side of our body. Our lower field gives us a view of the ground and the upper visual field covers space above our head. Thus the large field of vision allows us to easily manoeuvre safely in space.

- The right side of the brain is responsible for seeing the left side of the visual world. This means if the right side of the child’s brain is damaged, the left side of the visual world may not be seen and vice versa.
- The upper part of the back of the brain is responsible for seeing the lower part of the visual world. This means a child with damage in this area will not see the ground when looking straight ahead and may have a tendency to trip up.
4. Impaired visual memory and impaired visual imagination
This means the child has problems remembering things seen and in learning new tasks as visual imagination is used to work out the sequence of moves to complete a task.

5. Impaired depth perception
This means the child has a lack of understanding of 3-dimensional images impacting on:
- Walking up and downstairs
- Stepping up and down pavements
- Reaching out for an object accurately

6. Impaired perception of movement
This means the child has difficulty in:
- Visually following moving objects (tracking)
- Seeing detail in moving targets such as the television
- Seeing and interpreting their own movements through space
Part 2: Guidelines

Cerebral Visual Impairment

Guidelines for health care professionals and educational professionals

“My home: stairs, people and windows”
Drawing by S.H., a five years old girl with CVI.

http://www.teachcvi.net

Copyright © 2017 by the TeachCVI project (Erasmus+ project)
Cerebral Visual Impairment (CVI) is considered as one of the principal causes of visual impairment in children, especially in developed countries. Yet CVI is still often misunderstood and misdiagnosed.

These guidelines, developed by the TeachCVI team, are designed as a tool to assist health care and educational professionals who are working with children at risk for CVI. For more information on the following topics, see http://teachcvi.net/.

We provide guidance on:

- What is Cerebral Visual Impairment?
- Risk factors
- Signs and symptoms
- Consequences
- Assessment
- Access to literacy
- Treatment / Intervention
- Teaching strategies

What is Cerebral Visual Impairment?

Cerebral Visual Impairment (CVI) is a term used to describe visual impairment due to injury to the visual pathways and centres of the brain.

CVI is not caused by a disorder of the eyes, but the visual system of the brain do not consistently understand or interpret what the eyes see. Thus, processing of visual information is impaired.
The degree of visual impairment depends on the severity and location of the neurological damage as well as time of onset. The range of possible outcomes is wide, both in terms of vision and associated impairments.

Visual outcomes can range from total blindness to mild disturbances in visual perception and frequently these children can also present neurological disorders such as cerebral palsy, epilepsy and learning disability.

For clinical purposes, children with CVI can be grouped into three categories:
- Children with profound visual impairment due to CVI, many of whom have additional disabilities
- Children with CVI who have better functional visual abilities and some cognitive and motor challenges
- Children with CVI who have sufficient vision, that allows them to work at or near the expected academic level for their age group. Some can have additional motor disorders

CVI is not an indicator of the child’s cognitive ability but it may have an adverse impact on the child’s development.

**Risk factors**

Because vision involves so many areas of the brain, processing and interpreting visual information is a complex task. Therefore, injury to and malfunction in these areas is likely to impact adversely on the functioning of the visual system.
The brain damage leading to **CVI** can occur:

- Before the child is born
- During or immediately after birth
- Later during the child's life

Most common risk factors for **CVI** are:

- Prematurity, especially birth before 34 weeks gestation
- Periventricular white matter disease
- Lack of blood supply or oxygen to the brain
- Developmental brain defects
- Low blood sugar at birth
- Hydrocephalus
- Infections of the central nervous system (e.g. meningitis and encephalitis)
- Head injury

Sometimes there is no obvious cause.
Signs and symptoms

Signs of CVI are variable and no single sign is characteristic of the condition. Common characteristics of visual function demonstrated by children with CVI may include what is presented in the diagram.

Young children with CVI can appear blind during the first months but their vision tends to improve. Children with CVI may also have problems with the basic visual functions such as visual acuity, contrast sensitivity and visual field.
Consequences

**CVI** can for instance have an impact on:

- Near vision tasks
- Access to literacy
- Communication and social interaction
- Daily living and learning skills
- Orientation and mobility

**CVI** can also lead to:

- Visual fatigue
- Anxiety

Assessment

**CVI** should be considered as the cause for visual impairment when the visual behaviour is not fully explained by the ophthalmological examination. The eye movements are frequently abnormal (nystagmus or strabismus) and visual functioning is variable. Clinicians frequently have to rely on observations and the child’s health history to diagnose **CVI**.

The assessment is best made by a multidisciplinary team following an ophthalmological evaluation, comprising a visual function and a functional vision assessment, a neurological examination and a (neuro) psychological evaluation. Frequently an MRI scan of the brain is part of the diagnostic process as well.
Early diagnosis of CVI is crucial, as early intervention may improve the outcome. In order to facilitate early diagnosis, CVI screening lists have been developed.

On our website, you can find these screening lists and an overview of the regional multidisciplinary teams you can refer to for CVI assessment.

Access to literacy

Literacy is not only about the ability to read and write. It is an act of liberation and empowerment, of taking a role as an active citizen in society. Literacy is “reading the word and the world” (Freire & Macedo, 1987).

The Convention on the Rights of the Child states:

“The child shall have the right to freedom of expression; this right shall include freedom to seek, receive and impart information and ideas of all kinds, regardless of frontiers, either orally, in writing or in print, in the form of art, or through any other media of the child’s choice.” (United Nations Convention on the Rights of the Child, Article 13).

Children with CVI have specific and diverse needs when it comes to literacy exposure and experiences. Many lack opportunities to engage naturally in incidental learning. Professionals from different fields share the responsibility to support children with CVI to gain access to literacy and give them an opportunity to achieve their maximum potential.

The TeachCVI project supports the concept of literacy as a continuum starting at birth.
<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
<th>Age*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Building a Foundation for Literacy</strong></td>
<td>E.g. chews on books, enjoys rhymes, attends to pictures, understands that an object can be a symbol for an activity, etc.</td>
<td>0 – 2</td>
</tr>
<tr>
<td><strong>Early Emergent Literacy</strong></td>
<td>Pretends reading, listens to stories, recites and fills in phrases in a story, scribbles, draws, etc.</td>
<td>2 – 4</td>
</tr>
<tr>
<td><strong>Emergent Literacy</strong></td>
<td>Understands that text and pictures convey meaning, begins to recognize familiar environmental print and their name, may write some letters, etc.</td>
<td>4 – 5</td>
</tr>
<tr>
<td><strong>Developing Literacy</strong></td>
<td>Awareness that words are made of different sounds, decodes words, writes simple sentences, etc.</td>
<td>6 – 7</td>
</tr>
<tr>
<td><strong>Early Independent Literacy</strong></td>
<td>Shifts from “learn to read” to “read to learn”, reads independently for a longer time, writes own ideas and observations, etc.</td>
<td>8 – 9</td>
</tr>
<tr>
<td><strong>Independent Literacy</strong></td>
<td>Reads confidently and independently in multiple modes of text, written work is organized, coherent and easily understood, etc.</td>
<td>10 – 11</td>
</tr>
<tr>
<td><strong>Expanding Literacy</strong></td>
<td>Reading for acquisition of knowledge, analyses and thinks critically about ideas presented in text, writes for a variety of reasons and in diverse modes, etc.</td>
<td>11+</td>
</tr>
</tbody>
</table>

*Age ranges indicate when one would expect children without disabilities to be engaged in the activities and behaviours listed and are provided for general reference only.*
Treatment / Interventions

The principal aim of all early intervention measures for children with CVI is to minimise the impact of disability on the child’s development, facilitate independent daily living skills, minimise social disadvantage and increase the quality of life.

The following approaches are aimed at minimising the consequences of CVI:

- Ensuring that environmental conditions and all communication materials used are accessible and matched to the developing needs of the child
- Developing efficient strategies to maximise-visual capacities
- Encouraging functional compensation of other senses like tactile, auditory, etc.

Teaching strategies

A structured programme of support can make a huge difference in outcomes for children with CVI (see teaching material on http://www.teachcvi.net/).

The following strategies can be used:

- Use multisensory stimulation of vision, hearing, touching and olfaction
- Allow lots of time and intermittent breaks for the child to see and respond to stimuli. A great deal of energy is needed to process information visually and the child might tire easily
- Try to keep visual information as simple, constant and predictable as possible
- Use toys and activities that motivate the child
- Try to interpret the child’s subtle response cues: for instance changes in breathing patterns, shifts of gaze or head and body position
Chapter I: General information about CVI

Resources

Part 3: Screening tool for children with CVI

1. INSTRUCTION SCREENING LISTS FOR CHILDREN WITH CVI

These screening tools are developed as a first step to decide when to refer children with a suspicion of CVI to specialised centres for further assessment. The screening tools cover lower, middle and higher visual functions.

**Note: these are screening tools, not diagnostic tools!**

Each screening list starts with some general questions about the child (e.g. medical, developmental and visual problems). Next, there is a list of questions that screen for CVI. The parents, teacher, health care professionals or other interested persons need to fill in every question to the best of their ability by indicating the number that is the most applicable to the child. The numbers correspond to: (1) never, (2) occasionally, (3) frequently and (4) always. At the end of the screening list, we have provided some space to allow further comments if necessary and to clarify which questions were hard to answer.

There are three screening lists for three different groups:

- Screening list CVI 1: This screening list is focused on children with a motor disability who are non-ambulant.
- Screening list CVI 2: This screening list is focused on children with a developmental age between two and six years old.
- Screening list CVI 3: This screening list is focused on children with a developmental age between six and twelve years old.
So far there is no ICD-10 code for the diagnosis of CVI. Most often the ICD-10 code H47.6, disorders of visual cortex, and H47.7, unspecified disorder of visual pathways, are used. For your convenience, we refer to CVI diagnosis although this isn’t specified in ICD-10.

**The following offers a guide on how to apply the screening lists:**

1. Parents, teachers, health care professionals and other interested persons fill in the screening list.
   - On the introductory page questions 1 and 2 are for parents, teachers, health care professionals and other interested persons. Questions 3 to 5 only apply to parents.
   - It is important to emphasise that the screening list needs to be filled into the best of participants’ knowledge. Considered responses will provide the most useful information.
   - Provide an opportunity to discuss the screening lists with the parents/teachers/health care professionals/other interested persons, particularly about questions they are not sure about. This will maximise the likelihood that every question can be filled in to the best of each participants’ knowledge.

2. Healthcare professionals score and review the screening tools.
   - At the moment there is no scientific research carried out on these screening lists. The scoring is based on previous research\(^{11}\) and professional experience.

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- The answers that are indicative for CVI are marked bold for each question and specific screeners are indicated for each screening list:
  - Scoring list 1
  - Scoring list 2
  - Scoring list 3
- Healthcare professionals need to count the number of bold answers.
- The healthcare professionals should also check whether or not screeners are marked:
  - Screeners list 1: **6 screeners**
    - Item 6: Use of vision can fluctuate.
    - Item 10: Does not recognise common objects.
    - Item 12: Can find a favourite toy easily when it is amongst other toys.
    - Item 14: Looks away while reaching out for an object.
    - Item 17: Notices an object only when it moves.
    - Item 19: Reacts to sound rather than to visual stimuli.
  - Screeners list 2: **8 screeners**
    - Item 4: Tilts head to look at something.
    - Item 15: Looks away while reaching out for an object.
    - Item 20: Does not recognise common objects.
    - Item 22: Recognises common objects only when drawn in colour.
    - Item 25: Has difficulties with interpreting more complex drawings (e.g. overview picture/situation picture).
    - Item 26: Can find a favourite toy easily when it is amongst other toys.
    - Item 31: Has difficulty walking down steps.
    - Item 34: Touches an object in preference to looking at it.
• Screeners list 3: **8 screeners**
  
  o Item 4: Tilts head to look at something.
  
  o Item 15: Looks away while reaching out for an object.
  
  o Item 22: Does not recognise common objects.
  
  o Item 27: Can find a favourite toy easily when it is amongst other toys.
  
  o Item 32: Has difficulties with interpreting more complex drawings (e.g. overview picture/situation picture).
  
  o Item 33: Has difficulties with following the line when reading.
  
  o Item 39: Has difficulties walking down steps.
  
  o Item 43: Has difficulties perceiving the movement of objects (e.g. movement of a car or movement of a ball).

- A positive screen is based on the number of marked screeners and/or the number of marked items:
  
  • Screening list CVI 1 – There is a positive screen if:

    o 3 out of 6 screeners are indicated with or without additional marked items;

    o Or 6 or more items are marked (1/3 of the screening list).

  • Screening list CVI 2 – There is a positive screen if:

    o 4 out of 8 screeners are indicated with or without additional marked items;

    o Or 11 or more items are marked (1/3 of the screening list).

  • Screening list CVI 3 – There is a positive screen if:

    o 4 out of 8 screeners are indicated with or without additional marked items;

    o Or 15 or more items are marked (1/3 of the screening list).
3. Healthcare professionals provide feedback of the screening results to the parents.

4. The following offers guidance on how to address the findings from the screening:

- **Negative screen:**
  - No further assessment for CVI needed: No immediate concern for CVI and further assessment is not needed. Some reassurance may be needed and other worries must be taken care of. Re-screen after 6 months if clinical concerns persist.
  - High risk for CVI: No immediate CVI diagnosis but there are grounds for concern (e.g. prematurity, cerebral palsy ...) that given the presence of certain characteristics a CVI diagnosis might emerge in the future, suggesting the need for ongoing monitoring and assessment. Re-screen after 6 months if clinical concerns persist.

- **Positive screen:** This requires immediate assessment by a multidisciplinary team. This team should have involvement from a number of specialists, such as paediatrician or paediatric neurologist, ophthalmologist, low vision therapist, (neuro)psychologist, physiotherapist ... to assess the child’s general developmental abilities. For more information about the multidisciplinary team, see www.teachcvi.net/

  - No CVI diagnosis: Visual perceptual and functional visual abilities are within normal range. Reasons for clinical problems should be sought elsewhere and, if possible, guidance for the child and his caregivers.
• CVI diagnosis: Visual perceptual and functional visual abilities are impaired. Healthcare providers need to anticipate the need for guidance and start the (re)habilitation plan.

• CVI working hypothesis: Suspicion of CVI remains, but the assessment does not reveal clinical results. Therefore it is important to monitor the development of the child and re-screen and re-assess the child after a certain period. Follow-up and guidance is needed.
Chapter I: General information about CVI

SCREENING MODEL FOR CHILDREN WITH A SUSPICION OF CVI

Parents, teachers and interested others complete screening

Medical staff scores and reviews screening tools

Negative screen

No CVI assessment needed
- Discuss results and concerns with parents
- Anticipate guidance (e.g. referral to appropriate early intervention unit or a centre for assessment, rehabilitation and counselling)
- Rescreen in six months if clinical concerns persist

High risk for CVI
- Discuss results and concerns with parents
- Anticipate guidance (e.g. referral to appropriate early intervention unit or a centre for assessment, rehabilitation and counselling)
- Rescreen in six months if clinical concerns persist

Positive screen

Assessment of general developmental abilities and CVI

CVI diagnosis
- Discuss results and concerns with parents
- Immediate action required
- Anticipate guidance

No CVI diagnosis
- Discuss results and concerns with parents
- Immediate action required
- Anticipate guidance

CVI working hypothesis
- Discuss results and concerns with parents
- Immediate action required
- Anticipate guidance
- Monitor development of the children with the working hypothesis of CVI
- Rescreen and re-assess after a certain period
2. SCREENING LIST CVI 1

Screening list for children with a suspicion of Cerebral Visual Impairment (CVI)

1) General information
Date questionnaire filled in: .................................................................
Filled in by (name): ...........................................................................
Relation to the child:

☐ Parent
☐ Teacher
☐ Health care professional
☐ Other interested person (please specify: ........................................)

2) Information about the child
Name: ................................................................................................
Date of birth: ................................................................. Age: ......y........m
Gender:

☐ Male
☐ Female
☐ Other

3) Pregnancy and birth
Pregnancy duration: ............. weeks Birth head circumference: ....... cm
Birth weight: ........... grams
Multiple births:

☐ Yes: .........................(e.g. twin or triplet)
☐ No

Were there any problems during the pregnancy?

☐ Yes
☐ No
If yes, please specify the problems:

........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................

Delivery:

☐ Normal/vaginal delivery
☐ Caesarean delivery
☐ Using specific medical procedures (e.g. forceps in childbirth or vacuum extraction)
☐ Don't know (e.g. adoption)

Were there any problems during the delivery?

☐ Yes
☐ No

If yes, please specify the problems:

........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................

4) Medical and/or developmental issues

Is your child being seen for any medical or developmental issues such as ADHD, Autism Spectrum Disorder, epilepsy, motor problems, growth disorders, or others issues?

☐ Yes
☐ No
If yes, please specify the issues:

........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................

Does your child receive therapy/help for these issues?

☐ Yes
☐ No

If yes, from whom?

........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................

Is your child on medication?

☐ Yes
☐ No

If yes, please specify which medication and why your child takes medication.

........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................

5) Visual problems

Does your child have known visual problems?

☐ Yes
☐ No
If yes, has the child been examined by an ophthalmologist/orthoptist/optometrist?

- Yes
- No

If yes, what problems were determined?

- Problems with visual acuity: Acuity right: ....................
  Acuity left: .....................
- Visual field loss
- Strabismus
- Amblyopia/lazy eye
- Refractive errors
- Other:
  ...................................................................................................................
  ...................................................................................................................
  .....................

Have glasses been prescribed?

- Yes
- No

If yes, please specify why the child has glasses.

...................................................................................................................
...................................................................................................................
...................................................................................................................
...................................................................................................................
......................................................................................................................
For each question, circle the number that applies to your child

Below there is a list of questions that screen for Cerebral Visual Impairment (CVI).

Circle the number that is the most applicable to the child. Please do so for each question and trust your instinct.

The numbers correspond to:

<table>
<thead>
<tr>
<th>1 = Never</th>
<th>2 = Occasionally</th>
<th>3 = Frequently</th>
<th>4 = Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Makes eye contact.</td>
<td>1 2 3 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Has difficulties with looking at objects.</td>
<td>1 2 3 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Has difficulties with looking at people.</td>
<td>1 2 3 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Stares at light sources (e.g. lights or windows).</td>
<td>1 2 3 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Notices objects positioned at waist level or below.</td>
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3. SCORING LIST CVI 1

Screening list for children with a suspicion of Cerebral Visual Impairment (CVI)

Scoring

The answers that are indicative for CVI are marked bold for each question and specific screeners are indicated for each screening list.

Healthcare professionals need to check whether the responses of the parents/teachers/interested others correspond with these bold answers and need to count the number of these responses. They should also check whether or not screeners are marked.

A positive screen is based on the number of marked screeners and/or the number of marked questions. There is a positive screen if:

- 3 out of 6 screeners are indicated with or without additional marked items;
- Or 6 or more items are marked (1/3 of the screening list).

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Number of screeners: ...............

Number of answers that are indicative for CVI: ...............
4. SCREENING LIST CVI 2

Screening list for children with a suspicion of Cerebral Visual Impairment (CVI)

1) General information
Date questionnaire filled in: ..............................................................................................
Filled in by (name): ........................................................................................................
Relation to the child:
- Parent
- Teacher
- Health care professional
- Other interested person (please specify: .................................................................)

2) Information about the child
Name: ............................................................................................................................
Date of birth: ................................................. Age: ..................y..................m
Gender:
- Male
- Female
- Other

3) Pregnancy and birth
Pregnancy duration: ........... weeks Birth head circumference: ...... cm
Birth weight: ........... grams
Multiple births:
- Yes: .........................(e.g. twin or triplet)
- No

Were there any problems during the pregnancy?
- Yes
- No
If yes, please specify the problems:

Delivery:
- Normal/vaginal delivery
- Caesarean delivery
- Using specific medical procedures (e.g. forceps in childbirth or vacuum extraction)
- Don’t know (e.g. adoption)

Were there any problems during the delivery?
- Yes
- No

If yes, please specify the problems:

4) Medical and/or developmental issues
Is your child being seen for any medical or developmental issues such as ADHD, Autism Spectrum Disorder, epilepsy, motor problems, growth disorders, or others issues?
- Yes
- No
If yes, please specify the issues:
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Does your child receive therapy/help for these issues?

☐ Yes
☐ No

If yes, from whom?
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Is your child on medication?

☐ Yes
☐ No

If yes, please specify which medication and why your child takes medication.
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5) Visual problems

Does your child have known visual problems?

☐ Yes
☐ No

If yes, has the child been examined by an ophthalmologist/orthoptist/optometrist?

☐ Yes
☐ No
Chapter I: General information about CVI

If yes, what problems were determined?

- Problems with visual acuity:
  - Acuity right: ......................
  - Acuity left: ......................

- Visual field loss
- Strabismus
- Amblyopia/lazy eye
- Refractive errors
- Other:
  ........................................................................................................................................
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Have glasses been prescribed?

- Yes
- No

If yes, please specify why the child has glasses.

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For each question, circle the number that applies to your child

Below there is a list of questions that screen for Cerebral Visual Impairment (CVI).

Circle the number that is the most applicable to the child. Please do so for each question and trust your instinct.

The numbers correspond to:
1 = Never  2 = Occasionally  3 = Frequently  4 = Always

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5. SCORING LIST CVI 2

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Healthcare professionals need to check whether the responses of the parents/teachers/interested others correspond with these bold answers and need to count the number of these responses. They should also check whether or not screeners are marked.

A positive screen is based on the number of marked screeners and/or the number of marked questions. There is a positive screen if:

- 4 out of 8 screeners are indicated with or without additional marked items;
- Or 11 or more items are marked (1/3 of the screening list).

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Number of screeners: ..............

Number of answers that are indicative for CVI: ..............
6. SCREENING LIST CVI 3

Screening list for children with a suspicion of Cerebral Visual Impairment (CVI)

1) General information
Date questionnaire filled in: .................................................................
Filled in by (name): ............................................................................
Relation to the child:
- Parent
- Teacher
- Health care professional
- Other interested person (please specify: ............................................)

2) Information about the child
Name: ..................................................................................................
Date of birth: ......................................................... Age: ...........y.........m
Gender:
- Male
- Female
- Other

3) Pregnancy and birth
Pregnancy duration: .......... weeks Birth head circumference: ...... cm
Birth weight: .......... grams
Multiple births:
- Yes: .....................(e.g. twin or triplet)
- No

Were there any problems during the pregnancy?
- Yes
- No
If yes, please specify the problems:

Deliveries:
- Normal/vaginal delivery
- Caesarean delivery
- Using specific medical procedures (e.g. forceps in childbirth or vacuum extraction)
- Don't know (e.g. adoption)

Were there any problems during the delivery?
- Yes
- No

If yes, please specify the problems:

4) Medical and/or developmental issues

Is your child being seen for any medical or developmental issues such as ADHD, Autism Spectrum Disorder, epilepsy, motor problems, growth disorders, or others issues?
- Yes
- No
If yes, please specify the issues:

Does your child receive therapy/help for these issues?
- Yes
- No

If yes, from whom?

Is your child on medication?
- Yes
- No

If yes, please specify which medication and why your child takes medication.

5) **Visual problems**

Does your child have known visual problems?
- Yes
- No

If yes, has the child been examined by an ophthalmologist/orthoptist/optometrist?
- Yes
- No
If yes, what problems were determined?

- Problems with visual acuity:  
  - Acuity right: ......................
  - Acuity left: ......................

- Visual field loss
- Strabismus
- Amblyopia/lazy eye
- Refractive errors
- Other:
  ..........................................................................................................................................
  ..........................................................................................................................................
  ........................

Have glasses been prescribed?

- Yes
- No

If yes, please specify why the child has glasses.

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For each question, circle the number that applies to your child

Below there is a list of questions that screen for Cerebral Visual Impairment (CVI).

Circle the number that is the most applicable to the child. Please do so for each question and trust your instinct.

The numbers correspond to:

1 = Never  
2 = Occasionally  
3 = Frequently  
4 = Always

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<table>
<thead>
<tr>
<th></th>
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<tr>
<td>1.</td>
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<td>2</td>
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<tr>
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<td>2</td>
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<td>3.</td>
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<tr>
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<td>Tilts head to look at something.</td>
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<td>2</td>
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<tr>
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<td>Has difficulties following moving objects.</td>
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<td>2</td>
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<tr>
<td>6.</td>
<td>Has difficulties following moving people.</td>
<td>1</td>
<td>2</td>
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<td>7.</td>
<td>Stares at light sources (e.g. lights or windows).</td>
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<td>2</td>
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<td>Falls over clearly visible objects.</td>
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<tr>
<td>9.</td>
<td>Orientates the head downwards when walking.</td>
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<td>14.</td>
<td>Objects need to be brought close to be seen.</td>
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<td>15.</td>
<td>Looks away while reaching out for an object.</td>
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<td>2</td>
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<td>Reacts adversely in a strange or unfamiliar environment (e.g. shop or street).</td>
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<td>17.</td>
<td>Has difficulties distinguishing familiar from unfamiliar faces.</td>
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<td>Reacts adversely to traffic sounds or suddenly produced sounds.</td>
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<td><strong>3 = Frequently</strong></td>
<td><strong>4 = Always</strong></td>
</tr>
<tr>
<td>20. Has difficulties distinguishing familiar from unfamiliar faces in a crowd.</td>
<td>1</td>
<td>2</td>
<td>3</td>
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<tr>
<td>21. Has difficulties with finding the way in unfamiliar environments (e.g. in a restaurant or department store).</td>
<td>1</td>
<td>2</td>
<td>3</td>
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<tr>
<td>22. Does not recognise common objects.</td>
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<td>2</td>
<td>3</td>
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<tr>
<td>23. Does not recognise common pictures/images.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>24. Recognises common objects only when drawn in colour.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>25. Recognises people by their voice, clothes and posture rather than looking at their faces.</td>
<td>1</td>
<td>2</td>
<td>3</td>
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<tr>
<td>26. Has difficulties when the lay-out of a room/class has changed.</td>
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<td>27. Can find a favourite toy easily when it is amongst other toys.</td>
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<td>28. Has difficulty catching a ball.</td>
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<td>29. Gets lost in crowded places (e.g. shopping mall or big group of children).</td>
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<td>2</td>
<td>3</td>
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<tr>
<td>30. Is able to find objects/images on a patterned background (e.g. a chair in a room with a lot of furniture or detail in a complex picture).</td>
<td>1</td>
<td>2</td>
<td>3</td>
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<tr>
<td>31. Has difficulties placing objects in a certain spatial position (e.g. table in front of a chair, ball on top of the chair or doll at the right side of the chair).</td>
<td>1</td>
<td>2</td>
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<td>32. Has difficulties with interpreting more complex drawings (e.g. overview picture/situation picture).</td>
<td>1</td>
<td>2</td>
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<tr>
<td>33. Has difficulties with following the line when reading.</td>
<td>1</td>
<td>2</td>
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<tr>
<td>34. Has difficulties with passing to the next line when reading.</td>
<td>1</td>
<td>2</td>
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<tr>
<td>35. Can keep writing along the line.</td>
<td>1</td>
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<td>36. Has difficulties with passing to the next line of writing.</td>
<td>1</td>
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<tr>
<td>37. Has difficulties with reading the clock.</td>
<td>1</td>
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<tr>
<td>38. Has difficulties with visual representations (e.g. timelines, tables or weekly schedules).</td>
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<td>1 = Never</td>
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<tr>
<td>39. Has difficulty walking down steps.</td>
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<tr>
<td>40. Hesitates when there is a change of floor surface (e.g. from a wooden floor to a carpet or when encountering steps).</td>
<td>1 2 3 4</td>
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<tr>
<td>41. Hesitates where a floor pattern changes (e.g. from black to white tiles).</td>
<td>1 2 3 4</td>
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<tr>
<td>42. Likes to play group games (e.g. football or basketball).</td>
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**Further comments and questions that were difficult to answer:**

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7. SCORING LIST CVI 3

Screening list for children with a suspicion of Cerebral Visual Impairment (CVI)

Scoring

The answers that are indicative for CVI are marked bold for each question and specific screeners are indicated for each screening list.

Healthcare professionals need to check whether the responses of the parents/teachers/interested others correspond with these bold answers and need to count the number of these responses. They should also check whether or not screeners are marked.

A positive screen is based on the number of marked screeners and/or the number of marked questions. There is a positive screen if:

- 4 out of 8 screeners are indicated with or without additional marked items;
- Or 15 or more items are marked (1/3 of the screening list).

<table>
<thead>
<tr>
<th></th>
<th>1 = Never</th>
<th>2 = Occasionally</th>
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Number of screeners: ..............

Number of answers that are indicative for CVI: ..............
Part 4: An example of assessment program of children with CVI

1. OPHTHALMOLOGICAL ASSESSMENT

Vision Assessment in Children

http://www.teachcvi.net
Copyright © 2017 by the TeachCVI project (Erasmus+ project)

Vision

- The ability to see and distinguish between differences among shapes, patterns and colours.
- The ability to recognize and use that information.
- Develops in infancy and matures during early childhood.
Ophthalmological evaluation

- An ophthalmologist is a medical doctor who specializes in the medical and surgical care of the eyes, the visual system and in the prevention of eye diseases and injury.
- A multidisciplinary approach with paediatricians, optometrists, orthoptists and low vision specialists adds to an in depth understanding of the child and their vision.

History

- Mother’s health before and during pregnancy
- Pregnancy:
  - Duration
  - Birth weight
- Pregnancy and breast feeding:
  - Toxic or infectious agents
  - Use of medication
  - Fever or rash
- Family history
- The child’s health and development


History

- Specific questions regarding the child's vision:
  - Eye contact
  - Fixation
  - Behaviour
  - The ability to follow an object
  - Interest in his/her surroundings
  - In play and the interaction with others
  - …

- The parents perception is important – intuition/insight (e.g. the parents perception of the child's eye-sight)

- It's important to also talk to the child, not just the parents and note the given response.

The ophthalmologist’s first general assessment
The ophthalmologists first general assessment

- Observations during the examination:
  - General appearance of the eyes:
    - Strabismus (position of the eyes)
    - Nystagmus (involuntary eye movements)
    - Eye motility
    - Size
    - Asymmetry
    - Surface anatomy of the eyes and the surrounding tissue

Assessing vision
Assessing vision

○ Overview – Specific testing: Methods depending age, health and development of the child:
  • Position of the eyes:
    – Observation of deviations
    – Evaluation of size and angle
    – Corneal light reflex
    – Cover/uncover test (for those who can maintain fixation)
    – Fixation behaviour
    – Observation of eye movements

Assessing vision

○ Overview – Specific testing: Methods depending age, health and development of the child:
  • Pupillary responses:
    – Response to light
    – Accommodation-convergence reflex
  • Stereo vision
  • Visual acuity testing:
    – Preferential looking
    – Optotype testing
  • Measurement of refraction – sciascopy/retinoscopy
Assessing vision

- **Overview** – Specific testing: Methods depending on age, health and development of the child:
  - Visual field testing:
    - Confrontational testing
    - Perimetry testing
      - Manual perimetry (e.g., Arc perimeter and Goldmann)
      - Automated perimetry (e.g., Humphrey and Octopus)
  - Colour vision assessment
  - Contrast vision assessment

Assessing vision

- **Overview** – Additional testing which aids in the evaluation of the child’s eyes, optic nerves and higher visual system (brainstem and brain):
  - Electrophysiology testing:
    - Visual Evoked Potential (VEP)
    - Electroretinogram (ERG)
  - Neuroimaging (to be discussed with the neuro- or developmental paediatrician)
Assessing vision – Specific testing

- **Position of the eyes**
  - Hirschberg test – Light reflex of the cornea
  - Cover/uncover test – Alternating cover test, prism cover test for quantitative measurement of strabismus
  - Strabismus (squint, deviation of an eye) is caused by lack of coordination between the extraocular muscles, so both eyes do not have parallel lines of sight, thereby hampering proper binocular vision and possibly depth perception. Tropia/phoria. Can cause diminished vision and amblyopia

Assessing vision – Specific testing

- **Fixation behaviour**
  - The visual system at birth is functional but limited
  - Visual fixation is usually present in full-term alert new-borns, but the ability to follow targets is habitually not observed until later (often about 2 months of age)
  - The stability and duration of fixation is also low to begin with (often up until 5 months of age)
  - However, the lack of ability to fixate is usually an indicator of poor visual function as children get older
Assessing vision – Specific testing

- Fixation behaviour

![Image of baby and an object]

Assessing vision – Specific testing

- Eye movements
  - The movements of the eyes are voluntary and involuntary
  - To track an object one uses three types of voluntary eye movements and these movements are thought to originate in the frontal lobe of the brain:
    - Smooth pursuit
    - Vergence shifts
    - Saccades
  - Six extra-ocular muscles facilitate the movements of the eyes and three cranial nerves carry signals from the brain to control these muscles
Assessing vision – Specific testing

- Eye movements
  - Movements are described as:
    - Elevations – Pupil directed upwards
    - Depression – Pupil directed downwards
    - Abduction – Pupil directed laterally
    - Adduction – Pupil directed medially
    - Extorsion – Top of eye rotating away from the nose
    - Intorsion – Top of eye rotating towards the nose
  - The child’s ability to track/follow an object is tested at close range, for one eye and both eyes

Assessing vision – Specific testing

- Eye movements
  - Nystagmus:
    - Involuntary repetitive movement of the eyes
    - Can be horizontal, vertical or rotary, slow or fast and usually involves both eyes
    - Pathologic nystagmus can be congenital (3 – 6 months) or acquired, indicating an underlying visual or neurological problem
    - Can cause reduced vision
Assessing vision – Specific testing

- **Eye movements**
  - Nystagmus:
    - People with nystagmus from childhood may not be aware of their eye movements because what they see usually doesn’t appear shaky to them.
    - A tilt or turn of the head in order to see more clearly is common. This helps to dampen or slow the eye movements.

![Physiological nystagmus](Wikipedia)

Assessing vision – Specific testing

- **Pupillary responses**
  - Reflex that controls the diameter of the pupil in response to the intensity of light that falls on the retinal ganglion cells of the eyes, thereby assisting in adaptation to various levels of lightness/darkness regulating the intensity of light entering the eye.
  - The optic nerve, or more precisely, the photosensitive ganglion cells through the retino-hypothalamic tract, is responsible for the afferent limb of the pupillary reflex. It senses the incoming light.
  - The oculomotor nerve is responsible for the efferent limb of the pupillary reflex. It drives the muscles that constrict the pupil.
Assessing vision – Specific testing

- **Pupillary responses**
  - Accommodation-convergence reflex
    - The young human eye can change focus from distance (infinity) to 6.7 cm from the eye in 350 milliseconds. A change in focal power of approximately 15 diopeters.
    - With the accommodation reflex the eye adapts for near vision. The child focuses on a distant object (dilates the pupils), then shifts the gaze to a near object, whereby a normal response is a pupillary constriction and convergence of the axis of the eyes.

---

Assessing vision – Specific testing

- **Pupillary responses**
  - Accommodation-convergence reflex
    - Vergence is the simultaneous movement of both eyes in opposite directions to obtain or maintain single binocular vision.
    - Vergence is closely connected to accommodation. Under normal conditions, changing the focus of the eyes to look at an object at a different distance will automatically cause vergence as well as accommodation. The accommodation-convergence reflex.
Assessing vision – Specific testing

- **Stereovision**
  - Stereovision is the perception of depth and 3-dimensional structure obtained on the basis of visual information deriving from two eyes. It’s the highest degree of binocular vision.
  - Binocular disparities are processed in the visual cortex of the brain to yield depth perception.
  - Fine stereopsis is mainly based on static differences. It allows the individual to determine the depth of objects in the central visual area and is therefore also called quantititative stereopsis. It is typically measured in random-dot tests.
  - Testing stereovision:
    - Random dot stereotests (e.g., Lang stereotest)
    - Contour stereotests (e.g., Titmus stereotest)

Assessing vision – Specific testing

- **Stereovision**
  - Testing stereovision – Lang stereotest
    - Random dot stereotest
    - Consists of a random dot stereogram upon which a series of parallel strips of cylindrical lenses are imprinted in certain shapes, which separate the views seen by each eye in these areas, similarly to a hologram.
Assessing vision – Specific testing

- **Stereovision**
  - Testing stereovision – Titmus stereotest
    - Contour stereotest
    - The most well-known example is the Titmus Fly Stereotest where a picture of a fly is displayed with disparities on the edges. The patient uses 3D glasses to look at the picture and determine whether a 3D figure can be seen.

Assessing vision – Specific testing

- **Visual acuity testing – Preferential looking**
  - Infants demonstrate a greater tendency to look at a patterned stimulus than a homogeneous field
  - Normal values for development of “acuity” in the first year of life were estimated by identifying spatial stripe frequencies that were fixated longer than a homogeneous field by 75% of infants at a given age
  - Forced choice preferential looking tests:
    - Teller cards (masked observer looks through peeping whole in the boards)
    - Lea gratings
Assessing vision – Specific testing

- Visual acuity testing – Preferential looking
  - Forced choice preferential looking tests:

![Teller cards](image1)
![Lea gratings](image2)

Assessing vision – Specific testing

- Visual acuity testing – Preferential looking
  - Administration
    - The infant responds by turning the eyes or the head toward the striped target
    - Multiple trials are often needed
    - Detection of the finest grading gives the visual acuity
    - Measured in cycles/cm, taken into account the distance from the patient. The evaluation is in cycles/degree, which is converted (table) into Snellen measurements
Assessing vision – Specific testing

- Visual acuity testing – **Optotype testing**
  - An optotype is a symbol that, when correctly identified at a given distance, permits quantification of acuity
  - From 2-3 years old
  - Optotype tests:
    - E-test
    - Picture testing (e.g. Lea symbols or Kay pictures test)
    - Matching technique (e.g. HVOT chart or Sheridan-Gardner)

Assessing vision – Specific testing

- Visual acuity testing – **Optotype testing**
  - Administration:
    - Repeated tries at different times often necessary – learning curve
    - First tested binocularly, with and without refractive correction, then each eye
    - School age children tested with Snellen/LogMAR
Assessing vision – Specific testing

- Visual acuity testing – Optotype testing

Lea symbols

Assessing vision – Specific testing

- Visual acuity testing – Optotype testing

Kay pictures Test
Assessing vision – Specific testing

- Visual acuity testing – Optotype testing

HVOT chart or Sheridan-Gardner

Assessing vision – Specific testing

- Visual acuity testing – Conversion table

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</table>
Assessing vision – Specific testing

- Measurement of refraction
  - The exam:
    - Participation depends on the age of the child as well as its health and development
    - Exam to accurately measure refractive error, slit-lamp examination for evaluation of the anatomy of the eye, for diagnosis of abnormalities of the anterior segment and by indirect ophthalmoscopy (fundoscopy) with a lens to look for subtle abnormalities of the retina or optic nerve/nerve fiber layer
    - Dilation of the pupil for a better view/sciascopy
    - Uncooperative child – Examination under sedation or under anaesthesia

- Measurement of refraction
  - The exam:
    - After dilation of the pupils
    - Subjective measurement in older children
    - Prescription of glasses if needed
    - Prescription of occlusion treatment in younger children with suspected amblyopia
    - Amblyopia (lazy eye) is due to abnormal vision development in one or both eyes in childhood and is the most common cause of monocular blindness
Assessing vision – Specific testing

- Visual field
  - Young children with severely restricted visual fields can be identified by the confrontation technique
  - Visual field testing:
    - Confrontational testing – A figure is brought in from the periphery by one person while another watches the fixation/eye movements
    - Perimetry testing – Perimetry is a more suitable method to identify relative visual field defects in older children (from 6-7 years):
      - Manual perimetry
      - Automated perimetry

Assessing vision – Specific testing

- Visual field
  - Visual field testing – Perimetry testing
    - Manual perimetry (e.g. Arc perimeter and Goldmann):
      - Is a technique in which changes in size and intensity of a stimulus are used to detect relative visual field defects
      - A continuously monitoring of the fixation and cooperation of the child is important
      - The children are told to say ‘yes’ when they see the stimulus. Some children have problems saying when they see the stimulus. In these cases, the field can be measured by means of eye movements
    - Automated perimetry (e.g. Humphrey and Octopus)
Assessing vision – Specific testing

- Visual field
  - Visual field testing

![Visual field diagram]

Assessing vision – Specific testing

- Visual field
  - Visual field testing

![Goldmann and Confrontation testing images]
Assessing vision – Specific testing

- Colour and contrast vision
  - Colour discrimination and contrast sensitivity are present but poorly developed in new-borns
  - During the first six months of life – Rapid anatomic development in the eye and central visual pathway parallels a rapid improvement in visual acuity, contrast sensitivity and colour discrimination:
    - Maturation of the retina and retinal photoreceptor (rod and cone cells)
    - Myelination of the optic nerves and tracts
    - Increased synaptic density of the visual cortex

Assessing vision – Specific testing

- Colour and contrast vision
  - After six months of life – The visual system develops at a slower rate:
    - Myelination continues to increase in the central visual pathways until about four years of age
    - The development of the visual cortex continues throughout the first decade of life
Assessing vision – Specific testing

- **Contrast sensitivity**
  - Is the ability to detect gradations in brightness
  - Is the ability to distinguish between object and background. A test of visual function.
  - Visual acuity drops in situations of low contrast and the quality of vision suffers
  - Contrast testing provides information about the visual performance (visual acuity is tested in high contrast), face recognition, stairs and different lightning conditions
  - Contrast sensitivity tests:
    - Pelli Robson – Contrast Sensitivity Chart
    - Lea Hyvarinen – Heeding Heidi Low Contrast Test
    - Preferential looking

Assessing vision – Specific testing

- **Contrast sensitivity**
Assessing vision – Specific testing

- Contrast sensitivity

  Pelli Robson – Contrast Sensitivity Chart
  Lea Hyvarinen – Heiding Heidi Low Contrast Test

Assessing vision – Specific testing

- Colour vision
  - Is the ability to distinguish objects based on the wavelengths (or frequencies) of the light they reflect, emit or transmit
  - Colours can be measured and quantified in various ways
  - A person’s perception of colours is a subjective process whereby the brain responds to the stimuli that are produced when incoming light reacts with the several types of cone cells in the eye
  - In essence, different people see the same illuminated object or light source in different ways
  - Parallel channels lead from the retina to the thalamus carrying information into the visual cortex, where colour is ultimately determined
Assessing vision – Specific testing

- **Colour vision**
  - In very low light levels, vision is scotopic – Light is detected by rod cells of the retina. Rods are maximally sensitive to wavelengths near 500nm and play little, if any, role in colour vision.
  - In brighter light, such as daylight, vision is photopic – Light is detected by cone cells, which are responsible for colour vision.
  - Colour blindness can be:
    - Total or partial (more common)
    - Blue/yellow or red/green (more common, 8% of males)

Assessing vision – Specific testing

- **Colour vision**
  - Colour vision testing:
    - Ishihara Color Test – red/green
    - Farnsworth Color Vision Test – red/green and blue/yellow
    - Waggoner computerized color test
    - Functional implications
Assessing vision – Specific testing

- Colour vision
  - Colour vision testing:

Ishihara Color Test

Assessing vision – Specific testing

- Colour vision
  - Colour vision testing:

Farnsworth Color Vision Test
Assessing vision – Additional testing

- Visually Evoked Potential (VEP)
  - Can be useful for assessing visual function in children with developmental disabilities, ocular motor apraxia and cortical visual impairment
  - The occipital lobe’s electrical response to retinal stimulation is measured
  - It takes about 100ms from light stimulation of the retina until the response of the cortex. In case of damage somewhere between the retina and the cortex, the response is altered (longer duration or reduced amplitude)
  - The interpretation takes experience
Assessing vision – Additional testing

- **Electroretinogram (ERG)**
  - Measures the electrical responses of various cell types in the retina, including the photoreceptors (rods and cones), inner retinal cells (bipolar and amacrine cells) and the ganglion cells
  - Electrodes are usually placed on the cornea (contact lens) and the skin near the eye, although it is possible to record the ERG from skin electrodes
  - During a recording the patients eyes are exposed to standardised stimuli and the resulting signal is displayed showing the time course of the signals amplitude (voltage)

Assessing vision – Additional testing

- **Electroretinogram (ERG)**
  - ERG is used for the diagnosis of various retinal diseases
  - Used under anaesthesia in children with suspected retinal problems/visual impairment
Children with a suspicion of CVI

- **Evaluation of each child**
  - The evaluation of each child is different
  - Which methods are chosen for vision assessment depends on the problems at hand as well on the child itself
Children with a suspicion of CVI

- **Children with suspected CVI**
  - Are evaluated the same as all other children
  - Other pathology, if present, must be accounted for and attended to
  - Refraction and amblyogenic factors must be evaluated and corrected if needed
  - The history and examination is very indicative and important in the evaluation and diagnosis of children with suspected CVI
  - Evidence provided by imaging procedures, such as MRI, is important

- **Children with suspected CVI**
  - The diagnosis and follow-up is a multidisciplinary approach with pediatricians and ophthalmologists. Also genetics and imaging specialists (radiologists) work together
  - Early intervention with detailed assessment and visual training is paramount, with special pedagogues, low vision specialists and opticians working closely with the parents and caregivers of the child
Final thoughts

- Please note that provided information are not exhaustive.
- This publication was supported by the Erasmus+ Programme of the European Commission.
- This publication reflects the views of the authors, partners of the TeachCVI projects. Therefore, the Commission cannot be held responsible for any use of the information contained herein.
- Find more information about the TeachCVI project on the website: http://www.teachcvi.net
- Copyright © 2017 by the TeachCVI project (Erasmus+ project)
2. NEUROPSYCHOLOGICAL / PSYCHOLOGICAL ASSESSMENT

A selection of existing tools for the (neuro)psychological assessment of Cerebral Visual Impairment (CVI)

http://www.teachcvi.net
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Multidisciplinary team

- The diagnosis of Cerebral Visual Impairment (CVI) requires the participation of a multidisciplinary team

- A multidisciplinary team should include:
  - Pediatric neurologist / pediatrician
  - Ophthalmologist / orthoptist / optometrist
  - (Neuro)psychologist
  - Low vision therapist / special education teacher

And might also include:
- Physiotherapist
- Occupational therapist
- Speech language therapist
- Special education teacher
- Social worker / social care worker
Assessment tools

- The physiotherapist assesses the motor skills, and more specific the visuo-motor skills

- The (neuro)psychologist / educationalist is responsible for:
  - The (neuro)psychological assessment
  - Observations of free play or in a classroom
  - Interactions with caregivers
  - Interviews with parents or caregivers

- There are various assessments and observational tools available that can be used as part of the diagnosis of CVI. This list is intended to be comprehensive, but should not be taken to be exhaustive. These tools are currently used by professionals in the countries participating in the TEACH CVI project.

Note: it is always necessary to assess the cognitive abilities of the child as well!

Attention / Neglect
# Overview

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<tr>
<th>Age Group</th>
<th>BSID-II</th>
<th>NEPSY-II</th>
<th>NEPSY-II</th>
<th>NEPSY-II</th>
<th>NEPSY-II</th>
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<td>TEA-Ch</td>
<td>Cookie Theft Picture</td>
<td>CDT</td>
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</tr>
</tbody>
</table>

## BSID-II – Bayley Scales of Infant Development, 2nd edition

- **Aim**: Determine the mental and motor development level

- **Specification**: The BSID-II consists of:
  - Mental scale
  - Non-verbal scale
  - Motor scale
  - Behavioral scale

- **Age**: 1m – 42m

- **Time**: 45 minutes
Bayley-III – Bayley Scales of Infant and Toddler Development, 3rd edition

- **Aim**: Examines all facets of a young child’s development
- **Specification**: Developmental domains of the Bayley-III:
  - Adaptive behavior
  - Cognitive
  - Language
  - Motor
  - Social-emotional
- **Age**: 1m – 42m
- **Time**: 30 – 90 minutes

G.CVI.Tods (ongoing research)

- **Aim**: Visual perceptual test for toddlers
- **Specification**: Test battery for toddlers aged 22 till 33 months:
  - Visual recognition subtests
  - Pursuit of motion subtest
  - Visual field subtest
- **Age**: 22 till 33 months
- **Time**: 30 – 45 minutes
# NEPSY-II – Developmental Neuropsychological Assessment

- **Aim**: Provides comprehensive information about the neuropsychological functioning of the child.

- **Specification**: Measures 6 domains: memory and learning, sensomotor functioning, social perception, visuospatial processing, executive functioning/attention and language.

- **Age**: 3y 0m – 16y 11m

- **Time**: 45 minutes – 3 hours

---

# Visual search task

- **Aim**: The visual search task measures visual attention.

- **Specification**: The child has to search and indicate the target stimulus as soon as possible.

- **Age**: 3y – 6y

- **Time**: 10 – 15 minutes
TEA-Ch – Test of Everyday Attention for Children

- **Aim**
  The aim of this test is to measure attention problems in children

- **Specification**
  The battery measures: selective attention, sustained attention, attention control/switching and response inhibition

- **Age**
  6y – 16y

- **Time**
  60 minutes

Cookie Theft Picture

- **Aim**
  The Cookie Theft Picture measures visual attention

- **Specification**
  This is a subtest of the Boston Diagnostic Aphasia Examination (BDAE). The subject has to examine the picture and describe everything he/she sees happening

- **Age**
  Children and adults

- **Time**
  10 minutes
CDT – Clock Drawing Test

- **Aim**: The CDT provides information about memory, information processing and vision.

- **Specification**: The CDT consists of 2 tasks:
  - Free drawn clock
  - Clock copying task

- **Age**: Children and adults

- **Time**: 15 – 20 minutes

---

Line bisection task

- **Aim**: This is a quick measure to detect the presence of unilateral spatial neglect.

- **Specification**: The subject must place a mark through the center of a series of horizontal lines.

- **Age**: Children and adults

- **Time**: 15 – 20 minutes
UFOV – Useful Field of View Test

- **Aim**
  This is a test that assesses parallel attention processing.

- **Specification**
  The test contains 3 subtests which measure the ability to perform a central visual identification task, to divide attention between central and peripheral stimuli and to select peripheral stimuli among distracters.

- **Age**
  Adults

- **Time**
  30 minutes

Bells Test

- **Aim**
  The Bells Test is a cancellation test that assesses visual neglect.

- **Specification**
  The subject has to circle 35 bells embedded within 280 distractors (houses, horses ...)

- **Age**
  Adults

- **Time**
  5 minutes
BIT – Behavioral Inattention Test

- **Aim**
  The BIT is a test for assessing unilateral visual neglect

- **Specification**
  The test consists of 2 subtests:
  - Conventional subtests (6): line crossing, letter cancellation, star cancellation …
  - Behavioral subtests (9): phone dialing, article reading, map navigation …

- **Age**
  19y – 83y

- **Time**
  60 minutes

---

Lines / Visuospatial processing
Overview

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<thead>
<tr>
<th>Age Group</th>
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<th>PDMS-2</th>
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<td>M-ABC-II</td>
<td>M-ABC-II</td>
<td>WRAVMA</td>
<td>BVRT</td>
<td>Bender-Gestalt II</td>
<td>PDMS-2</td>
<td></td>
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</tr>
<tr>
<td>&gt; 18y</td>
<td>JLO</td>
<td>DTVP-A</td>
<td>MVPT-3</td>
<td>Beery VMI</td>
<td>TVPS-3</td>
<td>EFT</td>
<td>RCFT</td>
<td>NEPSY-II</td>
<td>M-ABC-II</td>
<td>M-ABC-II</td>
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<td>M-ABC-II</td>
<td>WRAVMA</td>
<td>BVRT</td>
<td>Bender-Gestalt II</td>
<td>PDMS-2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PDMS-2 – Peabody Developmental Motor Scales, 2nd edition

- **Aim**: This is an early childhood motor development program that assesses the motor skills of children

- **Specification**: The test contains 6 subtests: reflexes, stationary locomotion, object manipulation, grasping, and visual-motor integration

- **Age**: 0y – 5y

- **Time**: 45 – 60 minutes
Preschool JLO – Preschool judgement of line orientation

- **Aim**: This test measures visuospatial judgement

- **Specification**: The subject is asked to indicate which line on the bottom of the page is in exactly the same position and points in the same direction as the line on top of the page

- **Age**: 3y – 6y

- **Time**: 25 minutes

---

JLO – judgement of line orientation

- **Aim**: This test measures visuospatial judgement

- **Specification**: The subject is asked to indicate which line on the bottom of the page is in exactly the same position and points in the same direction as the line on top of the page

- **Age**: 7y – 74y

- **Time**: 25 minutes
DTVP-2 – Developmental Test of Visual Perception, 2nd edition

- **Aim**: This test measures both visual perception and visual-motor integration skills.

- **Specification**: The test consists of:
  - 4 visual perceptual tasks: position in space, figure ground, visual closure and form constancy
  - 4 visuo-motor tasks: eye hand coordination, copying, spatial relations and visual motor speed

- **Age**: 4y 0m – 10y 11m

- **Time**: 35 – 60 minutes

DTVP-A – Developmental Test of Visual Perception, A version

- **Aim**: This test measures both visual perception and visual-motor integration skills.

- **Specification**: The test consists of 6 subtests: copying, figure-ground, visual-motor search, visual closure, visual-motor speed and form constancy

- **Age**: 11y 0m – 74y 11m

- **Time**: 25 minutes
### PVPT-3 – Motor-free Visual Perception Test, 3rd edition

- **Aim**
  This test measures an individual's visual perceptual ability, with no motor involvement needed to make a response.

- **Specification**
  5 categories of visual perception are measured: spatial relationship, visual closure, visual discrimination, visual memory and figure ground.

- **Age**
  4y – 94y

- **Time**
  20 – 30 minutes

---

### MVPT-V – Motor-free Visual Perception Test-Vertical

- **Aim**
  This test assesses problems in visual perception in individuals with hemispatial visual neglect.

- **Specification**
  All stimuli are presented vertically at the visual midline.

- **Age**
  18y – 94y

- **Time**
  25 minutes
### Beery VMI – Beery-Buktenica Test of Visual Motor Integration

- **Aim**: This test examines the integration of motor and visual skills.
- **Specification**: The test consists of a visuo-motor part and 2 additional tests: visual-motor integration, visual perception and motor coordination.
- **Age**: Full form: 2y – 100y. Short form: 2y – 8y.
- **Time**: 25 minutes.

### TVPS-3 – Test of Visual Perceptual Skills, 3th edition

- **Aim**: This test examines visual-perceptual skills without the involvement of motor ability.
- **Specification**: The test consists of 7 subtests: visual discrimination, visual memory, spatial relationships, form constancy, sequential memory, visual figure-ground, and visual closure.
- **Age**: 4y 0m – 18y 11m.
- **Time**: 30 – 40 minutes.
**EFT – Embedded Figures Test**

- **Aim**
  The EFT is a visual perceptual test

- **Specification**
  The test requires the subject to locate a previously seen figure within a larger complex figure. The test is comprised of 18 complex figures

- **Age**
  Different age groups

- **Time**
  20 minutes

![Embedded Figures Test Examples](image)

**PVMIA – Preschool Visual Motor Integration Assessment**

- **Aim**
  This test identifies visual motor integration deficits in preschoolers

- **Specification**
  Specific skills addressed by the PVMIA include: perception of position in space, awareness of spatial relationships, color and shape discrimination, matching two attributes simultaneously and the ability to reproduce what is seen

- **Age**
  3y 6m – 5y 6m

- **Time**
  20 – 30 minutes
M-ABC-II – Movement Assessment Battery for Children

- **Aim**: This test determines motor impairment in children

- **Specification**: The test contains 8 tasks for each range in three categories: manual dexterity, ball skills and static and dynamic balance

- **Age**: 3y 0m – 16y 11m

- **Time**: 20 – 40 minutes

---

WRAVMA – Wide Range of Visual Motor Abilities

- **Aim**: This test examines how children deal with visual-motor, visuospatial and fine motor tasks

- **Specification**: The test contains 3 subtests: drawing test, matching test and pegboard test

- **Age**: 3y 0m – 17y 11m

- **Time**: 15 minutes
Bender-Gestalt II

- **Aim**: This test is a motor and perception test
- **Specification**: Administration consists of two phases:
  - Copy phase
  - Recall phase
- **Age**: 3y 0m – 85y 11m
- **Time**: 10 – 15 minutes

RCFT – Rey Complex Figure Test and Recognitional Trial

- **Aim**: This test examines various cognitive processes including planning, organization, problem solving, memory, and perceptual-motor functions
- **Specification**: The test consists of 4 trials: copy trial, immediate recall, delayed recall and recognition
- **Age**: 6y 0m – 17y 11m
  - 18y – 89y
- **Time**: 45 minutes
**BVRT – Benton Visual retention Test, 5th edition**

- **Aim**: This test measures visual perception and visual memory

- **Specification**: The subject is given a booklet containing 10 blank pages on which he reproduces the design. The test can be administered in 5 different ways.

- **Age**: 8y – 74y

- **Time**: 30 – 60 minutes

---

**VOSP – Visual Object and Space Perception Battery**

- **Aim**: This test assesses object and space perception

- **Specification**: The test consists of 8 subtests divided into 2 categories:
  - Object recognition: incomplete letters, silhouettes, shape decision, progressive silhouettes
  - Spatial relations: dot counting, position discrimination, number location, cube analysis

- **Age**: Adult

- **Time**: 60 minutes
L-Post – Leuven Perceptual Organization Screening Test

- **Aim**: This test is a computerized visual perceptual screening test.

- **Specification**: The test consists of 15 subtests that measure a wide range of processes of perceptual organization, such as segregation, local and global processing, grouping ... The test is freely available at http://gestaltrevision.be/tests/

- **Age**: Adult

- **Time**: 20 – 40 minutes

---

**Colour**
Overview

<table>
<thead>
<tr>
<th>Age Range</th>
<th>Tests Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 3y</td>
<td>Ishihara, AOHRR, PVMIA</td>
</tr>
<tr>
<td>3y – 6y</td>
<td>Ishihara, AOHRR</td>
</tr>
<tr>
<td>6y – 12y</td>
<td>Ishihara, AOHRR</td>
</tr>
<tr>
<td>12y – 18y</td>
<td>Ishihara, AOHRR</td>
</tr>
<tr>
<td>&gt; 18y</td>
<td>Ishihara, AOHRR</td>
</tr>
</tbody>
</table>

Ishihara Color Test

- **Aim**: This test is a color perception test for red-green color deficiencies.

- **Specification**: The test consists of 38 colored plates each of which contains a circle of dots appearing randomized in color and size. Within the pattern are dots which form a number or shape.

- **Age**: Children and adult

- **Time**: 15 – 20 minutes
AOHRR – American Optical Hardy-Rand-Rittler Color Vision Plates

- **Aim**: This test is a color perception test for red-green color deficiencies

- **Specification**: The test consists of 38 colored plates each of which contains a circle of dots appearing randomized in color and size. Within the pattern are dots which form a number or shape

- **Age**: Children and adult

- **Time**: 15 – 20 minutes

**Objects**
Overview

<table>
<thead>
<tr>
<th>&lt; 3y</th>
<th>3y – 8y</th>
<th>6y – 12y</th>
<th>12y – 18y</th>
<th>&gt; 18y</th>
</tr>
</thead>
<tbody>
<tr>
<td>BSID-II</td>
<td>VOT</td>
<td>VOT</td>
<td>VOT</td>
<td>VOT</td>
</tr>
<tr>
<td>Bayley-III</td>
<td>CVIT 3-6</td>
<td>BORB</td>
<td>Poppelreuter-Ghent-s Overlapping Figures Test</td>
<td>VOSP</td>
</tr>
<tr>
<td>G.CVI.Tods</td>
<td>L94</td>
<td>VOT</td>
<td>L-Post</td>
<td></td>
</tr>
</tbody>
</table>

VOT – Hooper Visual Organization Test

- **Aim**: This test assesses neurological impairment through a quick measure of visual integration, relatively unaffected by situational factors.

- **Specification**: The test consists of 30 line drawings, each showing a common object that has been cut into several pieces. The subject’s task is to tell you what the object would be if the pieces were put back together.

- **Age**: 5y and older

- **Time**: 15 minutes
CVIT 3-6 (ongoing research)

- **Aim**: Newly developed computerized test battery to measure different aspects of visual perception

- **Specification**: The subtests can be divided in 4 domains:
  - Object recognition in scene
  - Degraded object recognition
  - Perception of movement
  - Local and global processing

- **Age**: 2y 9m – 6y 3m
- **Time**: 30 – 45 minutes

L94 visual perceptual battery (1)

- **Aim**: This computerized test examines visual perceptual abilities

- **Specification**: The test consists of 5 subtests: the VOS-task, figures in noise, overlapping figures, visual matching, and non-conventional viewpoints

- **Age**: 2y 9m – 6y 3m
- **Time**: 45 minutes
L94 visual perceptual battery (2)

BORB – Birmingham Object Recognition Battery

- **Aim**
  The BORB provides a set of standardized procedures for assessing neuropsychological disorders of visual object recognition

- **Specification**
  The test consists of 14 subtests: drawing from memory, copying, length match task, size match task, orientation match task, position of gap match task, overlapping figures

- **Age**
  Adults

- **Time**
  60 minutes
**Poppelreuter-Ghent’s Overlapping Figures Test**

- **Aim**: This test measures visual recognition

- **Specification**: Subjects need to name and point out each of the overlapping figures (multiple choice)

- **Age**: Adults

- **Time**: 20 – 30 minutes

**Faces**
Chapter I: General information about CVI

Overview

<table>
<thead>
<tr>
<th></th>
<th>&lt; 3y</th>
<th>3y – 6y</th>
<th>6y – 12y</th>
<th>12y – 18y</th>
<th>&gt; 18y</th>
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</thead>
<tbody>
<tr>
<td>BSID-II</td>
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<td>NEPSY-II</td>
<td>NEPSY-II</td>
<td>Mooney</td>
<td></td>
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<tr>
<td>Bayley-III</td>
<td>CMS</td>
<td>CMS</td>
<td>BFRT</td>
<td>closure</td>
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<td>faces test</td>
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<td>BFRT</td>
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<td></td>
<td>WMS-IV</td>
<td></td>
</tr>
</tbody>
</table>

CMS – Children Memory Scale

- **Aim**: This test is a comprehensive learning and memory test for children

- **Specification**: The test measures learning in a variety of memory dimensions: attention and working memory, verbal and visual memory, short- and long-term memory, recall and recognitions, and learning characteristics

- **Age**: 5y – 16y

- **Time**: 60 minutes
BFRT – Benton Facial Recognition Task

- **Aim**: The test assesses face perception
- **Specification**: The subject has to recognize faces by matching a target face with the identical face out of 6 options
- **Age**: 6y – 99y
- **Time**: 30 minutes

WMS-IV – Wechsler Memory Scale, 4th edition

- **Aim**: The test measures the ability to learn and remember information presented verbally and visually
- **Specification**: The test measures a variety of memory dimensions: auditory memory, visual memory, visual working memory, immediate memory and delayed memory
- **Age**: 16y – 90y
- **Time**: 45 – 60 minutes
Mooney Closure Faces Test

- **Aim**: The test assesses face perception
- **Specification**: The subject needs to indicate a face
- **Age**: Adults
- **Time**: 30 minutes

Which one shows a face?

![Images of face outlines labeled 1, 2, and 3.]

Memory
Overview

<table>
<thead>
<tr>
<th>&lt;3y</th>
<th>3y – 6y</th>
<th>6y – 12y</th>
<th>12y – 18y</th>
<th>&gt;18y</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEPSY-II</td>
<td>NEPSY-II</td>
<td>NEPSY-II</td>
<td>NEPSY-II</td>
<td>CMVT</td>
</tr>
<tr>
<td>CMS</td>
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<td>CMS</td>
<td>CMS</td>
<td>BVMT-R</td>
</tr>
<tr>
<td>TVPS-3</td>
<td>TVPS-3</td>
<td>TVPS-3</td>
<td>TVPS-3</td>
<td>WMS-IV</td>
</tr>
<tr>
<td>RCFT</td>
<td>RCFT</td>
<td>RCFT</td>
<td>WMS-IV</td>
<td>RCFT</td>
</tr>
<tr>
<td>CMVT</td>
<td>BVRT</td>
<td>BVRT</td>
<td>CMVT</td>
<td>BVRT</td>
</tr>
</tbody>
</table>

CMVT – Continuous Visual Memory Test

- **Aim**
  The test measures visual learning and memory

- **Specification**
  The test consists of 3 tasks:
  - The acquisition task
  - The delayed recognition task
  - The visual discrimination task

- **Age**
  7y – 80y

- **Time**
  45 – 50 minutes
BVMT-R – Brief Visuospatial Memory Test - revised

- **Aim**: The test measures visuospatial memory

- **Specification**: The test consists of 3 subtests:
  - Learning trial
  - Delay trial
  - Copy trial

- **Age**: 17y – 79y

- **Time**: 45 minutes

**Motion**
### Overview

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 3y</td>
<td>G.CVI.Tods</td>
</tr>
<tr>
<td>3y – 6y</td>
<td>CVIT 3-6</td>
</tr>
<tr>
<td>6y – 12y</td>
<td>Biological motion</td>
</tr>
<tr>
<td>12y – 18y</td>
<td>Motion speed</td>
</tr>
<tr>
<td>&gt; 18y</td>
<td>Form from motion</td>
</tr>
<tr>
<td></td>
<td>Motion Coherence</td>
</tr>
<tr>
<td></td>
<td>L-Post</td>
</tr>
</tbody>
</table>

### Biological motion

- **Aim**: The test measures the perception of movement.
- **Specification**: There are two patterns of moving dots presented on the screen. One of them seems like a walking man. The child has to indicate this pattern of dots.
- **Age**: 4y 0m – 6y 11m
- **Time**: 10 – 15 minutes
**Motion speed**

- **Aim**: The test measures the perception of movement.

- **Specification**: There are moving dots presented in two cars. One car seems to move faster because of faster moving dots. The child has to indicate this car.

- **Age**: 4y 0m – 6y 11m

- **Time**: 10 – 15 minutes

---

**Form from motion**

- **Aim**: The test measures the perception of movement.

- **Specification**: There are three levels per item:
  - Level 1: in a square of moving dots there are several coherent moving dots that form a figure.
  - Level 2: in a square of moving dots a figure is shown (not moving dots).
  - Level 3: in a square of moving dots a figure is shown in black.

- **Age**: 4y 0m – 6y 11m

- **Time**: 10 – 15 minutes
**Motion coherence**

- **Aim**  
  The test measures the perception of movement

- **Specification**  
  There are two squares with moving dots presented on the screen. In one square there is a stripe with coherent moving dots moving to the right and left. The child has to indicate the square with the moving stripe

- **Age**  
  4y 0m – 6y 11m

- **Time**  
  10 – 15 minutes

---

**Final thoughts**
Final thoughts

- Please note that provided information are not exhaustive
- This publication was supported by the Erasmus+ Programme of the European Commission
- This publication reflects the views of the authors, partners of the TeachCVI projects. Therefore, the Commission cannot be held responsible for any use of the information contained herein
- Find more information about the TeachCVI project on the website: http://www.teachcvi.net
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3. ASSESSMENT OF VISUAL FUNCTIONS AND FUNCTIONAL VISION

Assessment of visual functions and functional vision for children with a suspicion of Cerebral Visual Impairment (CVI)

http://www.teachcvi.net
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Multidisciplinary team

- The diagnosis of Cerebral Visual Impairment (CVI) requires the participation of a multidisciplinary team

- A multidisciplinary team should include:
  - Pediatric neurologist / pediatrician
  - Ophthalmologist / orthoptist / optometrist
  - (Neuro)psychologist
  - Low vision therapist / special education teacher

And might also include:
- Physiotherapist
- Occupational therapist
- Speech language therapist
- Social worker / social care worker
Assessment of visual functions and functional vision

- There are various assessments and observational tools available that can be used as part of the diagnosis of CVI. This list is intended to be comprehensive but should not be taken to be exhaustive. These tools are currently used by professionals in the countries participating in the TEACH CVI project.

Definition and framework
Definition – Visual functions and functional vision

○ Visual functions
  • Describes how the eyes and the basic visual system functions.\(^1\)
  • Is the ability to process visual stimuli of a particular dimension, e.g. form, colour or motion \(^2\)

○ Functional vision
  • Describes how the person functions \(^1\)
  • The way vision is used in everyday life \(^2\)
  • The assessment of functional vision determines the impact of visual function on everyday life \(^2\)

Definition – Visual functions and functional vision

○ Overview
  • Basic visual functions – Oculomotor functions \(^3,4\)
  • Basic and middle visual functions. \(^3,4\) – Sensory functions \(^2\)
  • Relation between basic and middle visual functions and functional vision \(^3,4\)
  • Higher visual functions – Visual perception (dorsal stream) \(^2,3\)
  • Higher visual functions – Visual perception (ventral stream) \(^2,3\)
  • Relation between higher visual functions and functional vision \(^3,4\)
Definition – Visual functions and functional vision

- Check the visual status in children
  - Visual interest sphere / working distance: the best visual reaction within the visual field (e.g. angle, position or distance)
  - Body position: comfortable position in order to maximize functional vision and visual reactions
  - Basic visual functions: oculomotor and sensorial functions
  - Middle visual functions: motion perception
  - High visual functions: visual perceptual functions (if the intellectual level of the child supports this type of assessment)
  - Functional vision: using vision in communication / social interaction, daily living and learning skills, near vision tasks, orientation and mobility

Framework – Visual functions and functional vision

<table>
<thead>
<tr>
<th>Visual Functions</th>
<th>Functional Vision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual acuity, visual field, contrast, visual adaptation, colour vision etc.</td>
<td>Orientation and Mobility, Daily Living Skills, Communication, Sustained near activities</td>
</tr>
<tr>
<td>For each eye separately</td>
<td>For the person as a whole</td>
</tr>
<tr>
<td>Variable stimulus; fixed, threshold performance</td>
<td>Standardized task; variable performance or difficulty</td>
</tr>
<tr>
<td>Single variable, under controlled conditions</td>
<td>Multiple variable, under complex, real-life conditions</td>
</tr>
<tr>
<td>Threshold performance</td>
<td>Sustainable, supra-threshold performance</td>
</tr>
<tr>
<td>Visual parameters only</td>
<td>May also reflect non-visual factors</td>
</tr>
</tbody>
</table>
Basic visual functions – Oculomotor functions

- Overview
  - Visual interest sphere / working distance
  - Fixation and following movements – Ability to detect visual stimuli
  - Shift of gaze and saccades
  - Nystagmus
  - Strabismus – Alignment of the eyes orthophoria, esotropia or exotropia
  - Accommodation ex. eye contact and social smile
  - Convergence / divergence
Basic visual functions – Oculomotor functions

- **Visual interest sphere / working distance**: the areas within the visual field where children give the best visual feedback

Examples of materials and toys that can be used for establishing visual interest sphere / working distance in children with a suspicion of CVI (materials shared by Roxana Cziker)

Basic visual functions – Oculomotor functions

- **Visual fixation**: holding the image on the fovea or maintaining the visual gaze on a single location
- **Eye movements**: allow the eyes to closely follow a moving object
- **Shift of gaze and saccades**: quick eye movements from one stimulus to another

Examples of materials and toys that can be used for checking fixation and eye movements in children with CVI
Basic visual functions – Oculomotor functions

Black and white puppet and colour faces for assessing eye movements – visual fixation, following and saccades

Basic visual functions – Oculomotor functions

- **Alignment of the eyes** – Orthophoria, esotropia, exotropia, hypo- and hypertropia
- **Strabismus** – Deviation of the eyes, when directing the gaze to the same point in space
- The ophthalmologist is responsible for the assessment of strabismus. But it’s necessary for the members of the multidisciplinary team to recognize the effect of strabismus in functional vision assessment, since strabismus can have an effect on depth perception.
Basic visual functions – Oculomotor functions

- **Nystagmus**: fast involuntary and repetitive eye movements
- It often takes the form of horizontal oscillatory eye movements, which seem to badly disturb fixation
- Nystagmus should be observed during reading, play and training situations and observations
- How the child compensates for the nystagmus should be noted (position of head, eyes, etc.), when possible

Basic visual functions – Oculomotor functions

- **Accommodation** – Changing the focus from near to distance and vice versa

- **Convergence / divergence**
  - Convergence – Turning inward of the eyes when looking at close distances
  - Divergence – Turning outward of the eyes when looking on objects farther away
  - Assessment – Objects or images brought closer to the eyes and the gaze should shift from close to target far away
Basic visual functions – Oculomotor functions

- Accommodation - Eye contact and social smile: e.g. distance, reactions and visual behaviour
- Eye contact is one of the most important sign which confirms the accommodation and the first stage of visual communication

Eye contact and copying facial expression of mother (pictures from Lea Hyvarinen)

Basic visual functions – Oculomotor functions

- Role of oculomotor functions in daily life activities – Oculomotor functions are important in:
  - Selecting and detecting information within the environment
  - Noticing objects, people or actions in different areas of the visual field
  - Following visual stimuli in movement in playing situations, detection of landmarks in orientation situations, both indoor and outdoor
  - Using eye contact in communication with people
  - Seeing objects clearly both near and in distance
  - Able to switch the eyes from one point to another – e.g. from one picture to another in order to find the target picture or from one text line to another when reading
Basic and middle visual functions – Sensory functions

Overview

- Visual acuity
- Visual field
- Contrast sensitivity
- Colour vision
- Stereopsis
- Visual adaptation
- Motion perception
- Role of sensorial visual functions and movement in daily life activities
Basic visual functions – Sensory functions

- Visual acuity (VA) – Ability to resolve or recognise fine details
  - The ability to see details provides information about forms of objects, surfaces and textures
  - Recognition of very fine detail supports reading, which requires recognition of small images placed closely together
  - Visual acuity should be tested both near and at distance
  - You can use one of the three types of VA (detection, resolution and recognition) according to the child’s level of development

Basic visual functions – Sensory functions

- Visual acuity at distance (3m or less) – Detection acuity
  - Target detection requires only the perception of the presence or absence of an aspect of the stimuli, not the discrimination of target detail
  - The task of detection involves stating whether the spot or line is present:
    a) Bright test object on a dark background
    b) Dark test object on a bright background

(a)  (b)
Basic visual functions – Sensory functions

- Visual acuity at distance (3m or less) – Detection acuity
  - Dot visual acuity test
  - Catford Drum Test
  - Boek Candy Bead Test
  - STYCAR graded ball’s test

STYCAR test

Dot Visual Acuity Test

Basic visual functions – Sensory functions

- Visual acuity at distance (3m or less) – Resolution acuity
  - Target resolution thresholds are usually expressed as the smallest angular size at which subjects can discriminate the separation between critical elements of a stimulus pattern such as a pair of dots, a grating or a checkerboard
  - The task of resolution:
    a) Double dot target
    b) Acuity grating
    c) Checkerboard

(a) (b) (c)
Basic visual functions – Sensory functions

- Visual acuity at distance (3m or less)
  - Resolution acuity - Grating acuity
    - Preferential looking methods - LEA Paddles
    - Tellers Acuity Cards
    - Cardiff Acuity Test

- Visual acuity at distance (3m) – Resolution acuity
  - Grating acuity

Lea Grating Preferential Looking Test
Basic visual functions – Sensory functions

- Visual acuity at distance (3m) – Resolution acuity
  - Grating acuity

Teller Acuity Cards

Basic visual functions – Sensory functions

- Visual acuity at distance (1m or 0.5m) – Resolution acuity

Cardiff Acuity Test
Basic visual functions – Sensory functions

- Visual acuity at distance (6 m or less) – Recognition acuity
  - Target recognition tasks, which are most commonly used in clinical visual acuity measurements, require the recognition or naming of a target, such as Snellen letters or Lea tests

  The task of recognition: naming the test objects, in this case letters of the alphabet (Snellen)

Basic visual functions – Sensory functions

- Visual acuity at distance (6 m or less) – Recognition acuity
  - Optotypes
    - Symbol pictures: LEA or BUST (perception of form/visual acuity test)
    - Letters: HVOT or KM
    - Single symbols
    - Symbols in line (crowding)
    - Kay Pictures Test
Basic visual functions – Sensory functions

- Visual acuity at distance (6m or less) – Recognition acuity
  - Optotypes

LEA Symbols Flash Cards

LEA Symbols Single Symbol Book

Basic visual functions – Sensory functions

- Visual acuity at distance (6m or less) – Recognition acuity
  - Optotypes

Kay Pictures Test
Basic visual functions – Sensory functions

- Visual acuity near (40cm or less)
  - Symbols (LEA or BUST) or letters
    - Single symbols or letters
    - Linear array of symbols or letters
    - Crowding
  - Maclure reading test
    - Reading acuity
    - Words and sentence in sizes N5 – 48

Basic visual functions – Sensory functions

- Visual acuity near (40cm or less)

LEA symbols
Basic visual functions – Sensory functions

- **Visual acuity near (40cm or less)**

![Macular reading test](image)

Basic visual functions – Sensory functions

- **Visual field** – The peripheral fields extend our view almost to our shoulders on either side of our body. Our lower field gives us a view of the ground and the upper visual field covers space above our head. Thus the large field of vision allows us to easily manoeuvre safely in space.

- The binocular field is around 120 degrees.

- The monocular field extends 90 degrees from the midline to the sides and it is limited by the nose to the midline

- The vertical field extends 60 degrees above and 70 degrees below

Assessing the visual field in young children can be a challenge.
Basic visual functions – Sensory functions

○ Visual field

- Assessment can be done by observation and by using standardized instruments
- Examples of assessment tools
  - Rolling balls – observational tool
  - Ball on a stick – observational tool
  - LEA Flicker Wand (light spot) - observational tool
  - LEA Campimeter - standardized
  - Goldmann perimeter - standardized; best results when children are older then 7 to 12 years of age

![Ball on a stick](image)
Basic visual functions – Sensory functions

- Visual field

Lea Flicker Wand – observational tool

Lea Campimeter – standardized tool

Basic visual functions – Sensory functions

- Visual field

Arc perimeter – standardized tool
Basic visual functions – Sensory functions

- **Contrast sensitivity**
  - Ability to see differences in the amount of light reflected from adjacent surfaces. This ability allows us to notice edges and shadows that define objects and also shows us their depth and placement in space.
  - It is one of the most important visual functions in assessment, because it gives information about communication and perceiving the environment, which are mostly at low and intermediate contrast. 

Basic visual functions – Sensory functions

- **Contrast sensitivity**
  - Assessment tools:
    - Hiding Heidi (schematic faces)
    - LEA contrast test
    - Cardiff Contrast Test
    - KM contrast test (optotypes)
Basic visual functions – Sensory functions

- Contrast sensitivity

Hiding Heidi

Lea Symbols Low Contrast Test
10M Symbol Size

Lea Symbols Low Contrast Visual Acuity Charts
Basic visual functions – Sensory functions

- **Contrast sensitivity**

Cardiff Contrast Test

Basic visual functions – Sensory functions

- **Stereopsis**
  - Fine stereopsis is the highest function of binocular vision
  - Fine depth perception that results from the brain’s interpretation of the slight difference between the disparate pictures of the same visual scene provided by the two eyes

- **Gross stereopsis** appears to be used to judge stereoscopic motion in the periphery. Gross stereopsis is important for orientation in space while moving, for example when descending a flight of stairs

- **Fine stereopsis** is mainly based on static differences. It allows the individual to determine the depth of objects in the central visual area. Fine stereopsis is important for fine-motorical tasks such as threading a needle
Basic visual functions – Sensory functions

Assessment tools:
- Stereo Acuity Test Butterfly – test both gross and fine stereopsis
- Stereo Fly Test – test both gross and fine stereopsis
- Lang stereotest – test both gross and fine stereopsis

Basic visual functions – Sensory functions

- Stereopsis
  - Assessment tools

Stereo Acuity Test Butterfly

Stereo Fly Test
Basic visual functions – Sensory functions

- Stereopsis
  - Assessment tools

- Visual adaptation
  - The term visual adaptation describes the processes by which the visual system alters its operating properties in response to changes in the environment.
  - In very low light levels, vision is scotopic: light is detected by rod cells of the retina.
  - In brighter light, such as daylight, vision is photopic: light is detected by cone cells which are responsible for colour vision.
Basic visual functions – Sensory functions

- Visual adaptation
  - Assessment – Cone Adaptation Test

The Cone Adaptation Test is used to assess a person’s ability to adapt to lighting changes. The task is to sort the red, blue and white squares in the least amount of light necessary. Disturbed cone function may cause photophobia.

Basic visual functions – Sensory functions

- Colour vision
  - Colour vision is possible due to photoreceptors in the retina of the eye known as cones. These cones have light-sensitive pigments that enable us to recognize colour. Found in the central part of the retina, each cone is sensitive to either red, green or blue light.
  - Normally, the pigments inside the cones register different colours and send that information through the optic nerve to the brain. This enables you to distinguish countless shades of colour.
Basic visual functions – Sensory functions

- Colour vision
  - Assessment
    - Name, identify and recognize colours
    - Colour images, choose among different colours
    - Discriminate, sort and classify colours
    - Assessment of colour vision defects with standardized tests

Basic visual functions – Sensory functions

- Colour vision
  - Examples of assessment tools
    - LEA puzzle
    - Waggoner Colour Vision Testing Made Easy
    - PV 16
    - Ishihara
Basic visual functions – Sensory functions

- Colour vision test

Lea Puzzle

Basic visual functions – Sensory functions

- Colour vision

Waggoner Colour Vision Testing Made Easy
Basic visual functions – Sensory functions

- Colour vision test

Quantitative Colour Vision Test PV 16

Basic visual functions – Sensory functions

- Colour vision

Ishihara Colour Vision Test
Middle visual functions

- **Motion perception**
  - The capacity to see movement
  - Bilateral damage can cause impaired or absent visual perception of movement (akinetopsia) (Zihl et al. 1983)³

Middle visual functions – Motion perception

- **Motion perception**
  - Assessment

Animation for assessing the ability to perceive the motion
Relation between basic and middle visual functions and functional vision

- **Role of oculomotor functions in daily life activities** – Oculomotor functions are important in:
  - Selecting and detecting information within the environment
  - Fixate on objects, people or actions in different areas of the visual field
  - Following visual stimuli in movement in playing situations, detection of landmarks in orientation situations, both indoor and outdoor
  - Using eye contact in communication with people
  - Seeing objects clearly both near and in distance
  - Able to switch the eyes from one point to another – e.g. from one picture to another in order to find the target picture or from one text line to another when reading

Relation between basic and middle visual functions and functional vision

- **Role of sensorial visual functions and movements in daily life activities** – Sensorial functions and movement are important in:
  - Clearly seeing details about elements, pictures and text
  - Reading texts in different sequences and different backgrounds
  - Seeing details both near and at distance space
  - Moving freely in space by covering stimuli in different areas of the visual field
  - Noticing people in a group, making difference among stimuli within environment in different levels of contrast
Relation between basic and middle visual functions and functional vision

- Role of sensorial visual functions and movements in daily life activities – Sensorial functions and movement are important in:
  - Identifying and discriminating size, colour, shape of objects, pictures, people or actions
  - Adapting the vision in different light situation
  - Being independent in organizing and finding personal things by different criteria (size, shape, colour, etc.)
  - Perceiving movement scenes outdoor or on television

Higher visual functions – Visual perception
Higher visual functions – Visual perception

The ventral stream integrates occipital lobe functions with those of the temporal lobe structures that serve as the brain’s ‘visual library’, serving conscious recognition and visual memory.

The dorsal stream integrates occipital lobe and posterior parietal lobe function. It affords subconscious analysis of the visual scene integrated with analysis of data from other sensory inputs such as hearing. This brain area is thought to continuously map the components of the visual scene, providing a real-time, constantly refreshing, virtual, multimodal mental representation of the surroundings. 2

Higher visual functions – Visual perception 2, 3, 4

Dorsal stream “Where” – Parietal Lobe:
- processing of movement stimuli and visual guidance of movement
- control of ocular movements
- prehension of objects, visual guided
- crowding of text
- simultaneous perception
- finding people in a group
- visual attention

Ventral stream “What” – Temporal Lobe:
- details of objects
- recognition of shapes, objects, letters, numbers, words, landmarks
- recognition of human faces and facial expressions
Higher visual functions – Visual perception

- Screening tests
  - LEA Puzzle – Form perception
  - LEA Mailbox – Direction
  - Complex pictures – Recognition of details
  - LEA Faces – Recognition of facial expression
  - Coloured photos
  - Recognition of familiar faces

LEA Puzzle
Higher visual functions – Visual perception

- Screening tests – Lea Mailbox
- Assess visual perception of line orientation. Tests two components:
  - Information for the hand movements in the parietal lobe
  - Picture perception in the inferior temporal lobe

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LEA Mailbox
Higher visual functions – Visual perception

- Screening tests

Pictures – Recognition of details

Higher visual functions – Visual perception

- Screening tests
Higher visual functions – Visual perception

- Screening tests - LEA Rectangles Game:
  - Interpretation of length
  - Assessment of eye-hand coordination
  - Capacity of grasping
  - Interpretation of comparing lengths of the model
  - Ability to handle, grasp and move the rectangles over the model

Higher visual functions – Visual perception

- Screening tests

LEA Rectangles Game
Role of higher visual functions in daily life activities

The higher visual functions are important in:

- Recognize, identify and discriminate objects – orientation – recognize landmarks like buildings, trees, pathways; reading – recognizing letters and words
- Recognize and identify simultaneously multiple objects or people – finding a friend in a group of children in different spaces
- Build words from different letters and give a meaning (writing and understanding the written text)
- Copying pictures, drawings, letters, words, text under the visual control
- Recognizing people by their facial features and facial expressions – communication
- Moving freely in space in a very busy scene and objects / people in movement

References

Final thoughts

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Part 5: Terminology related to CVI

A

**Accommodation**
Automatic adjustment of the lens of the eye to maintain a clear image or focus on an object as the viewing distance varies.

**Achromatopsia**
Rare, inherited vision disorder in which a person has little or no ability to see colour. People with achromatopsia also commonly experience some vision loss, especially in bright light. The severity of achromatopsia varies. Although there is no cure or treatment for this disorder, people with achromatopsia can manage its symptoms. For example, they can wear sunglasses or tinted contact lenses to cope with bright light. They can use magnifiers and other devices for low vision to help them read, and telescopes to help them see distant objects.

**Agnosia**
A visual-cognitive disorder characterized by the inability to recognize and identify familiar visual stimuli (objects, faces, letters, places, etc.), despite sufficiently available visual and cognitive capacities. This term does not apply to difficulties with assigning labels/names to visual stimuli (Visual anomia).

**Akinetopsia**
A condition in which the individual can only see things when they are not moving.
Alexia
Difficulty in the naming of letters or words.

Amblyopia
A disorder of sight due to the eye and brain not working well together. Also known as a lazy eye. The impaired vision in one or both eyes, with no anatomical cause, is due to the impaired development of vision as a sequel to untreated optical (refractive) errors, impaired image formation due to an eye disorder such as cataract, or impaired eye alignment (strabismus).

Anisometropia
The condition in which the two eyes have an unequal refractive power.

Anomia
The inability to name objects or to recognize the written or spoken names of objects.

Anopia
A defect into the visual field.

Anosognosia
Lack of awareness of and insight into an obvious functional impairment because the subject is unable to detect the mismatch between assumed/expected function and the real functional status. Anosognosia typically occurs in about 30% of subjects with hemiplegia and neglect.

Aphakia
Is the absence of the lens of the eye due to surgical removal, a perforating wound or ulcer, or congenital anomaly.
Apraxia
A motor disorder caused by damage to the brain, in which the individual has difficulty with the motor planning to perform tasks or movements when asked. This can affect simple movements (e.g. gestures) after a verbal instruction or by imitation (ideomotor apraxia) or complex movements (e.g. preparing a cup of tea, dressing: ideational apraxia).

Astigmatism
A type of refractive error that focuses light at different points in front of or behind the retina rather than a single point, and results in blurred vision at all distances, due to the subtle asymmetric, non-spherical shape of the cornea.

Atrophy
The partial or complete wasting away of a part of the body.

B
Balint’s syndrome
A neuropsychological condition characterized by severe limitations: inability to perceive the visual field as a whole (simultanagnosia), difficulty in fixating the eyes (oculomotor apraxia) and inability to move the hand to a specific object by using vision (optic ataxia).

Binocular coordination
Use of both eyes together so the separate images from each eye (which are slightly different) are interpreted by the brain as a single image. At its highest form - stereopsis - an impression of depth can be obtained by the brain superimposing two slightly dissimilar pictures of the same objects.
Blindness
Absence of vision. Total blindness is complete absence of vision and is rare.

Blindsight
Slight awareness of, or reflex reaction to, moving targets, lights and colours in an area of apparently absent visual field.

Brain plasticity
The capacity of the brain to adapt its functions to altered environmental (or task) conditions by experience (environment-dependent plasticity) and Learning (practice-dependent plasticity) and to compensate for functional alterations of the brain, e.g. after injury or in pathophysiological states (functional compensation).

Brain ventricles
Fluid filled cavities in the middle of the brain. The nerve fibers of the optic radiation run close to the wall of the lateral ventricle and are thus vulnerable if there are circulatory disturbances in the highly vascular ventricles walls.

Brain stem
The area at the base of the brain that, along with the midbrain above it, carries the nerves fibers running in both directions between the brain and the body and receives and processes input from the cranial nerves, including those that serve hearing and eye movements.
**Brodmann area**
A region of the Cerebral cortex, which is defined by its structure and organization of cells. The Brodmann areas were originally defined and numbered by the German neuroanatomist Korbinian Brodmann, who in 1909 described 47 different cortical areas.

**C**

**Central acuity**
The capacity of the visual system to see in the central visual field.

**Central fixation target**
A target placed in the centre of a visual field test.

**Cerebellum**
A brain structure that ensures the control of emotion by the frontal lobes, movement of the body processed by the parietal lobes, and vision processed by the occipital lobes.

**Cerebral blindness**
Profound impairment or absence of vision due to bilateral damage to the visual pathways posterior to the lateral geniculate bodies that may be accompanied by damage to other regions of the brain that serve vision. Also known as cortical blindness.

**Cerebral cortex**
The layer of grey matter that covers the outside of the brain and consists of six layers of neurons.
Cerebral hypoxia
Lack of oxygen supply to the brain, which can be caused by impaired blood flow or impaired oxygenation due to respiratory disorders.

Cerebral palsy
Loss or impairment of motor function caused by damage or abnormal development of the brain before, during or immediately after birth.

Cerebral visual impairment (CVI)
Visual impairment due to the damage of the visual pathways and visual centres in the brain, including pathways serving visual perception, cognition, and visual guidance of movement.

Chiasma
Crossing of the optic nerves.

Colour deficiency
Inherited non-progressive condition in which the person confuses colours (red-green or blue-yellow axis).

Cognitive visual dysfunction
Disordered function of the brain related to the damage of the visual-associative areas and/or their incoming pathways leading to misinterpretation of the visual world (where things are or what they are).

Colour anomia
Inability to name colours.
Congenital
Existing at or before birth.

Contrast
The way that a foreground stands out from its background. Contrast is not a property of visual edges on the retina but of visual edges in space.

Contrast sensitivity
The ability of the visual system to distinguish the difference in brightness between two adjacent surfaces.

Convergence
The ability to turn the eyes inward as an object approaches them.

Cortical
Pertaining to the cerebral cortex.

Crowding
Vision is sometimes worse when crowded by other information e.g. words on the page too close together or patterns behind an object.

D
Dark adaptation
Refers to the gain in sensitivity as the eye remains in the dark. It is a relatively slow process, taking around 40 minutes to complete.
Detection acuity
Measures what the smallest object that a child notices on a contrasting background is.

Developmental age
A measure of a child’s level of development according to social, emotional, intellectual and physical growth.

Developmental disability
Mental or physical disability arising as a consequence of a disorder of development.

Diplegia
Paralysis or weakness of the lower limbs.

Dorsal stream
The pathway between the occipital and posterior parietal lobes provides vision for action and is mostly automatic and unconscious.

Dorsal stream dysfunction
Condition in which the function of the dorsal stream is disrupted, causing impaired visual guidance of movement and limiting the number of entities that can be seen in crowded scenes.

E
Eccentric viewing
Looking slightly above, below or to one side of an object in order to place a visual image onto an optimum area of the visual field of viewing.
**Electroencephalography (EEG)**
Along with its magnetic counterpart, magnetoencephalography (MEG), this procedure noninvasively records brain activity from the surface of the scalp to provide an indirect evaluation of the brain function.

**Emmetropia**
Condition in which the light coming from a distant object to the eye is focused accurately on the retina to make a focused image without the need for refractive correction.

**Encephalopathy**
Disorder of the brain due to disease, causing damage and malfunction.

**Epilepsy**
A group of conditions in which disturbance of the electrical activity of the brain results in impairment and disorder in a range of brain functions, including consciousness, movement, sensation and vision.

**Esotropia**
A condition in which one eye is horizontally turned inward; also known as convergent strabismus (US) or convergent squint (UK). Results in a lack of stereopsis.

**Executive functions**
Higher-order mental skills that are used to control and coordinate cognitive abilities and behaviours to achieve a particular goal.
Exotropia
A condition in which one eye is horizontally turned outward; also known as divergent strabismus (US) or divergent squint (UK). Results in lack of stereopsis.

Extrastriate visual areas
Visual cortical areas outside the Striate (primary) visual cortex; also called prestriate cortex or visual association areas.

F
Face recognition
The identification of an individual’s face on the basis of specific and characteristic facial features.

Figure-ground discrimination
The ability to discriminate an object from its surroundings; also called figure-ground perception.

Fixation
The ability to maintain the eyes focused on a target.

Form perception
The ability to judge the shape, size, texture, etc. of an object by vision or touch; also called form discrimination.

Fovea
The functional centre of the retina with the most numerous and tightly packed cone cells. This gives the sharpest vision.
**Frontal lobes**
Areas of the front of the brain, part of which serves the executive functions of thinking, planning and controlling behaviour.

**Functional skills**
Skills that students with multiple disabilities learn that provide them with the opportunity to work, play, socialize and take care of personal needs to the highest attainable level.

**Functional vision**
The way in which a person uses available visual skills and abilities in typical tasks of daily life. This it means how well an individual processes the visual information in his or her environment in order to go about daily tasks.

**Functional visual impairment**
Damage to the visual system that impedes the ability to learn or perform usual tasks of daily life.

**G**

**Gaze apraxia**
The impairment in using eye movements in a purposeful action, despite the intact capacity to carry out the eye movements.

**Grating**
A stimulus that consists of regular parallel light and dark elements.
Gross motor
Movement that involves the large muscles of the body such as the arms and legs (e.g. crawling, running, or jumping).

H
Hemianopia
Lack of perception of one half of the visual field.

Hemifield
One half of a sensory field.

Hemiparesis
Weakness on one side of the body.

Hemiplegic
Paralysis of one side of the body.

Higher visual functions
The combination of visual perception, visual cognition, guidance of movement and the capacity to choose to give visual attention.

Homonymous hemianopia
A visual field defect which the same half of the field of view is not seen by each eye.

Hydrocephalus
A condition in which there is an accumulation of cerebrospinal fluid (CSF) within the brain, causing increased intracranial pressure. With an increased CSF the ventricles of the brain will expand.
Hyperopia or hypermetropia
A condition of the eye in which light is focused behind, instead of on, the retina which results in blurred images. Also known as far-sightedness.

Hypertropia
An upward eye turn.

Hypoplasia
Underdevelopment of the body part.

Hypoxia
Lack of oxygen.

I
Impaired pursuit of movement
Disordered ability to pursue a moving target with the eyes.

Intermittent deviation
Turning of both eyes together in one direction for a variable duration, often with an accompanying head turn. Also paroxysmal deviation.

Ischemia
Insufficient supply of the blood.

J
Joint attention
An exchange that involves a child’s and a partner's awareness of the other’s mutual gaze, gesture or language.
L

Labyrinthine system
The subconscious automatic system in the inner ear and brain stem that is responsible for controlling and maintaining the balance.

Lateral geniculate nucleus (LGN)
A relay centre in the thalamus for the visual pathway. It receives a major sensory input from the retina. The LG is the main central connection for the optic nerve to the occipital lobe.

Letter agnosia
A selective type of visual agnosia, which is characterized by the loss of recognition of letters and/or the integration of letters into words.

Light adaptation
The capacity of the retina to adapt to increased levels of illumination.

Literal alexia
Inability to recognize certain individual letters due to damage to the brain.

Low vision
Visual impairment that is severe enough to impede the person’s ability to learn or perform usual tasks of daily life but still allows some functionally useful visual discrimination.

M

Magnetic resonance imagining (MRI)
A neuroimaging procedure that shows the anatomical features of the brain in great detail and can be used to study brain structure following injury.
**Magnocellular pathway**
A major pathway of the visual system that primarily transmits visual information in the peripheral visual field to the brain and serves movement perception, as well as facilitating visual guidance of movement.

**Mirror neuron system (MNS)**
A system in the brain that facilitate understanding and imitation of the actions of others.

**Motion perception**
The capacity to see movement.

**Myopia**
A type of refractive error that results in blurred images of the retina when viewing objects in the distance. Also known as near-sightedness.

**N**
**Neglect**
The inability to direct attention, which prevents a person of being aware of a part of space around or a part of herself. It may mean loss of attention in one half of the visual field.

**Neuroplasticity**
Refers to adaptation of neural pathways and structures due to changes in behaviour, environment and neural processes as well as changes resulting from injury due to learning processes.

**Nystagmus**
Unintentional or involuntary movement of the eyes.
Object permanence
The understanding that objects still exist when they cannot be seen, heard, touched, smelled or sensed.

Occipital lobes
Posterior parts of the cerebral cortex responsible for processing vision and sending visual information to other parts of the brain.

Occipitoparietal dysfunction
A disorder involving the occipital and parietal lobes of the brain, resulting in an impairment of the functions of both structures.

Ocular alignment
A description of the position of the eyes. If the eyes are out of alignment, strabismus is present.

Ocular visual impairment
Visual impairment caused by a disorder of the eye or optic nerve (but not the brain).

Oculomotor apraxia
Limited ability to move the eyes fast (saccadic eye movement) from one target to another.

Oculomotor scanning
Use of eye movements to scan the visual surrounding or a visual stimulus array (e.g. scene, object).
Oculomotor dysfunction
Impaired control of the eye movements leading to visual difficulties such as visual fixation or visual tracking problems, ocular alignment and impairment of accommodation.

Optic ataxia
Impaired accuracy of movement of limbs and body through visual space because visual guidance of movement is impaired.

Optic chiasm
The X-shaped structure formed by the joining up of the optic nerves, which cross and then become the optic tracts just below and leading into the brain.

Optic nerves
Bundle of nerve fibers (axons) from the ganglion cells of the retina. Nerves that transmit visual information from the retina of each eye to the brain.

Optic nerve atrophy
Atrophy means loss of functioning cells. The reason for cell damage may be infection, trauma, tumour or increased intraocular pressure.

Optic radiations
A collection of nerve axons that carry information from the lateral geniculate bodies in the thalamus to the visual cortex in the occipital lobes.

Optic tract
Bundles of nerve fibres that emerge from the back of the optic chiasm on each side that carry visual information to the lateral geniculate body.
Optokinetic nystagmus (OKN)
Reflex to and from movement of the eyes in response to moving targets.

Optometrist
A health care provider who specializes in the measurement of refractive errors and other visual functions, prescribes eyeglasses or contact lenses and (in some countries) diagnoses and manages conditions of the eye.

Optotypes
Letters and symbols used to test visual acuity.

Orientation perception
The capacity to know where one is, has been and will be going, as well as the position and location of possession.

Orthoptist
A specialist in measurement and management of disorders of the eye movements and binocular vision.

P
Parallax
The perception of the relative alignment of objects in relation to the position of viewing. A phenomenon that helps compensate for lack of stereopsis.

Parallel processing
The ability to simultaneously process several stimuli.
**Parietal lobes**
The parts of the brain that integrate incoming sensory information with the execution of body movements and process language.

**Parvocellular pathway**
A pathway of the brain served by small retinal and brain cells that transmit fine, detailed visual information primarily in the central visual field.

**Pattern perception**
The discrimination and identification of a set of stimuli arranged in a certain regular form, e.g. contours, figures, objects, faces, words, melodies.

**Perception**
The ability to see, hear or become aware of something through senses.

**Perceptual visual dysfunction**
A condition in which the brain is unable to process visual information correctly.

**Perinatal**
Around the time of the birth.

**Peripheral target**
A target placed at the outer edge of a person’s visual field.

**Peripheral visual field**
The area of vision outside the centre of an individual’s gaze.
Periventricular leukomalacia (PVL)
Damage to the white matter adjacent to the lateral ventricles of the brain.

Periventricular white matter
The white matter near to the ventricles of the brain.

Photophobia
Increased sensitivity to light.

Preferential looking (PL)
An experimental method in developmental psychology. An infant is habituated to a particular stimulus; then a second, new stimulus is shown, which differs from the habituated stimulus with respect to a specific feature (e.g. size, colour, form). If the infant now looks for longer at the new stimulus, it is suggestive that the infant can discriminate between the two stimuli. Preferential looking is now used routinely to estimate visual acuities in young children and those who are otherwise unable to cooperate with the use of other methods.

Prefrontal cerebral cortex
The anterior part of the frontal lobes of the brain that contributes to initiation and coordination of thoughts and actions.

Prematurity
Birth before 37 weeks’ gestation.

Prosopagnosia
Inability to recognize faces.
Pupil of an eye
The hole in the centre of the iris that allows light to enter the eye and, by its change in size, controls the amount of light passing through.

Pursuit eye movements
Smooth eye movements made while following an object. Also known as smooth pursuit movements.

Q
Quadrantopia
A defect in the visual field that affects a quarter of the visual field.

R
Recognition acuity
Ability to recognize and distinguish a specific visual target from other similar stimuli. Often measured using letter charts.

Refractive errors
An inaccuracy within the eye where the light rays do not come into clear focus on the retina, resulting in a blurred image.

Rehabilitation
Training to improve skills or behaviours that have been lost or decreased due to disease or injury.

Retina
The retina reacts to light and transmits visual information by means of nerve impulses to the brain.
Retinopathy of prematurity (ROP)
A disorder of the retina related to abnormal vascular development that occurs as a sequel to premature birth.

Rod cells
Sensory cells in the outer layer of the retina. They are highly sensitive to light and thus function best in twilight and scotopic conditions. In daylight their activity is not transmitted through the retina because the function of the cone cells inhibits it. The highest concentration of rod cells is in the peripheral parts of the retina.

S
Saccades
Fast voluntary eye movements, usually quick movements of both eyes simultaneously, used for tasks such as reading or scanning a scene.

Scanning
Making a series of visual fixations in order to visually inspect a large area.

Scotoma
A non-seeing area in the visual field.

Simultagnosia
Inability to see more than one item within the visual scene at the same time.

Spastic diplegia
A form of cerebral palsy resulting in weakness and stiffness of the lower limbs.
Spatial orientation
The perception of one’s own location in space and its adjustment with reference to objects in the same space.

Spatial vision
Perception of spatial properties of visual stimuli, e.g. position, orientation of contours, spatial configuration of figures, objects and scenes.

Stereopsis
Depth perception that results from the interpretation of the slight difference between pictures of the same visual scene provided by the two eyes.

Strabismus
Misalignment of the eyes. The eyes do not look in the same direction.

Striate (primary) visual cortex
The discrete region in the posterior occipital lobes of the brain that receives input directly from the eyes via the optic radiations, which serves primary visual functions, e.g. light detection. Also labelled Brodmann area 17 or V1 (visual area 1).

T
Temporal lobes
The areas of the brain under the temples that analyse the input from the senses. They provide the memory banks that underpin knowledge and recognition.
Text processing
The act of processing text material (letters, numbers). Essential prerequisites are an intact central visual field, a sufficiently high visual acuity and contrast sensitivity, accurate form discrimination, ability to integrate letters/numbers to larger elements and regular shifting of fixation. Text processing is the main basis for understanding of text material.

Thalamus
A structure situated between the cerebral cortex and the midbrain involved in processing and relaying sensory and motor signals to the cerebral cortex.

Threshold acuity
The lower limit of visual acuity measured with each eye separately for the purpose of diagnosis and follow-up of visual disorders.

Topographic agnosia
Disorientation in one’s surrounding. Impairments results from ventral stream damage and problem forming a mental map of the environment. Also known as topographic disorientation.

Tracking
Maintaining fixation on a moving object of interest using pursuit eye movements.
V

Ventral stream
Visual pathway between the occipital and temporal lobes, sometimes known as the “what” pathway, which supports the process of visual recognition. Dysfunction can cause impaired recognition of objects and persons, and impaired orientation in surrounding and extended space.

Ventricles
Fluid-filled cavities in the brain.

Vision loss
Lack of vision due to acquired damage to a previously intact visual system.

Visual acuity
A measure of the ability of the visual system to see or resolve the parts of an image as being separate from one another.

Visual attention
The ability to focus on specific elements in a visual scene by selecting and filtering out less salient information.

Visual blurring
It is observed when discrete boundaries between images are not seen as distinct, but instead merge into one another. This can be caused by refractive error and disorders of the eyes or visual pathways.

Visual brain
The totality of brain elements serving or supporting vision that serve to map, search, give attention to, recognize and interpret visual input.
Visual cognition
The capacity to process what is seen, to think about its significance, and to manipulate and use both incoming image data and remembered imagery in the context of creative thought.

Visual dysfunction
Disorder of the visual perception, visual guidance of movement, and/or visual attention.

Visual evoked potential (VEP)
Computerized recording of electrical activity at the back of the brain.

Visual field
Area of space visible to the eyes when looking straight ahead.

Visual functions
Measurable components of vision including visual acuity, contrast sensitivity, colour perception, visual field and the perception of movement.

Visual guidance of movement
Mapping of incoming visual information in the mind that is used to guide movement of the limbs and body.

Visual impairment
Damage to the visual system that impedes the ability to learn or perform usual tasks of daily life, given a child’s level of maturity and cultural environment. Includes both low vision and blindness.
Visual latency
The time taken to receive and process incoming visual information in the brain.

Visual guided motor behaviours
Behaviours with a major visual-motor component, including reaching for, turning toward, and moving among obstacles toward visual targets.

Visual memory
The ability to remember a visual image or form after viewing.

Visual-motor processing
Coordination of goal-directed motor actions in relation to a visual target.

Visual neglect
Inattention to one side of the visual space and/or to one side of the body.

Visual pathways
Bundles of nerve fibres that carry visual information to different location of the brain.

Visual perception
Ability to interpret the immediate environment by processing incoming information that is sent from the eyes to the brain.

Visual processing
The brain’s recognition and interpretation of information.
Visual recognition
The ability to recognize and identify objects, faces, geometric shapes and colours as well as pictures and images.

Visual search
The process of detecting a target stimulus among distractor stimuli.

Visual space perception
The sum of abilities to process and comprehend spatial properties of the environment and of objects, i.e. position, distance, direction, spatial relationships between stimuli.

Visual stimulation
An approach that places a child as a passive observer, in an environment in which selected visual stimuli are presented with the intention of bringing about attention and enhancement of visual development.

Visual system
Network that produces sight, including both the eyes and the brain.

Visuospatial perception
The capacity to appreciate, understand and map the three-dimensional characteristics of the surroundings, both for subjective appreciation and to facilitate movement through space.

W
WHAT pathway
Occipito-temporal route that is specialized for the processing of visual object properties (ventral pathway).
WHERE pathway
Occipito-parietal route that is specialized for the processing of visuospatial information (dorsal pathway).

Working memory
The ability to actively process information in temporary storage, with a phonological loop for the manipulation of verbal content and a visuospatial scratch pad for retaining of visual information.

References


