CVI

Cerebral Visual Impairment

Co-funded by the
Erasmus+ Programme
of the European Union

Preface 1

This project has been co-funded by the Erasmus+ Programme of the Education, Audiovisual and Culture Executive Agency of the European Commission.	
Key Action	KA2: Cooperation for innovation and the exchange of good practices.
Action Type	Strategic Partnerships for vocational education and training.
Reference	2015-1-FR01-KA202-015120

Co-funded by the Erasmus+ Programme of the European Union

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Project Information	
Identifier	2015-1-FR01-KA202-015120
Start Date	Sep 1, 2015
End Date	Aug 31, 2018
EC Contribution	298,203 EUR
Partners	Mutualité Française Anjou-Mayenne (FR); Association de Patronage de l'Institut Régional des Jeunes Sourds et des Jeunes Aveugles de Marseille (FR); Institut Royal pour Sourds et Aveugles (BE); Centar za odgoj i obrazovanje Vinko Bek (HR); Koninklijke Visio (NL); IECSCYL University of Valladolid (ES); Institut Nazareth et Louis-Braille (CA); Centre de Rééducation pour Déficients Visuels, Clermont-Ferrand (FR); ASPAYM Castille and Leon Foundation (ES)
Project Title	Cerebral Visual Impairment

In all the EU countries, rehabilitation centres specialised in the support of children with visual impairment have more and more cases of children with central visual disorders and a low vision. We can say that our organisations have already developed methodologies and procedures for the support of children for which the visual impairment is due to a dysfunction of the eye, as an organ. When visual impairment is caused by a cerebral background, the impact for children is totally different for the daily life, and the compensation means we use usually don't work. We think that more and more cases exist; this is due to the improvement of medical knowledge, and we didn't identify before the causes of their visual impairment. This is a real issue for all the rehabilitation organisations in Europe, which want to develop/set up a process of evaluation and support, as a standard for our organisations.

Our experience with these children shows us that there needs to be a specific approach in the understanding of the impact of their disabilities and in the support methodologies required. And despite the improvement of scientific knowledge on this question, methods of support are too often individual processes, without wider consultation and, locally, very isolated.

It seems very necessary to us to work together on the development of a coherent and multidisciplinary approach and protocol at EU level. In consequence, the objectives of our project have been to gather all the experiences of the partners and to develop a common process and common tools to improve the support of children with cerebral visual impairment. Our activities have included:

- Developing a methodology for a multidisciplinary assessment of central visual disorders, working with different professionals, for example: ophthalmologists, orthoptists, neuropsychologists.This work needed to identify all the existing tools used, and, where necessary, to adapt them to meet the identified needs of the target group, and to test them to validate the process.

- Developing an observation tool for use by relatives, parents, teachers. These observations are additional to and complete the professional evaluations, and they share the knowledge of the child in different life situations. The involvement of the environment in this project is essential for understanding disorders produced by the organic problem.

- Developing the structure/template of what we call an individual passport, in which is described simply for other people the impact of disorders on the life of the child.

- Afterwards, a period of experimentation of the process and tools with a representative sample of children in each country was carried out for the validation of the outcomes.
- Developing also a training plan for professionals to enable them to use the process of assessment and the tools used for that.

The methodology was as follows:

1. A phase of construction and agreement of the process for an EU standard (October 2015 - April 2017) : Elaboration of a common process based on the medical diagnosis, evaluation and shared observations (parents, professionals) which will give some tools for this process : Evaluation tool, questionnaire for gathering the observations in all daily life situations and the individual passport for a better understanding of the child.
2. A phase of validation (April 2017 - April 2018): the experimentation period with the aim to validate the process and tools carried out.
3. A phase of construction of a training curriculum (January - September 2018) : development of a training curriculum for professionals in the use of the procedure and the tools (in parallel with the end of the 2nd phase).
4. A phase of dissemination and communication (throughout the period of the project September 2015 - August 2018) with information on websites, flyers, to all existing networks (ENVITER, Francophone network, EASPD, EBU, etc.) and a conference planned in September 2018 in each country. The partnership will be led by MFAM, to ensure the follow-up of all activities with the aim, at the end of the project, of enabling all kinds of organisations involved in cerebral visual impairment, to use the tools/products which have been developed, for the benefit of children with cerebral visual impairment. During the project, partners will work together during the meetings planned, and in-between according to the schedule agreed by all the partners, and with existing tools (Skype, e-mails).

The products carried out will affect at least 5000 users, and in the future more than this figure (especially if we count all the indirect users like relatives, parents, teachers...) and they will be free for use by all kinds of organisations in Europe concerned in this issue[1].

[1] https://ec.europa.eu/programmes/erasmus-plus/projects/eplus-project-details/#project/2015-1-FR01-KA202-015120

In memory of

Iris Schreurs

1975-2017

On July 2017, during the implementation of this project, our colleague Iris Schreurs died at the age of 41 in an accident with a car whilst she was cycling with her husband. She was doing what she loved to do, and we will all miss her in many ways: as a great colleague, a hard worker and, especially, as a warm and welcoming person, full of hopes and plans for the future.

We wish to dedicate this Handbook in her memory, as a small testimony to her professional commitment, personal strength, her wish to help other people, and as encouragement for all those who knew her. We hope that this document, and the support for CVI children for whom it is developed, will continue to be remembered as part of her legacy. She will be forever in our memories.

Dedicated to Iris

Contents

Introduction 2

In all the EU countries, rehabilitation centres specialised in the support of children with visual impairment have more and more cases of children with central visual disorders and a low vision. That is why every organisation has already developed methodologies and procedures for their assessment and support. When the visual impairment is the result of a cerebral disorder, the impact for children is very different in daily life activities, and the procedures and tools used for the standard visual assessment and rehabilitation usually do not work. As prevalence is increasing exponentially, it becomes a problem for all the rehabilitation organisations providing re- habilitation for these children in Europe, and they want to establish a process of evaluation and support as a standard for their organisations.

At EU level, we need to improve the supporting tools for children with central visual disorders and a low vision. Our proposal is to establish a multidisciplinary common process for the evaluation of central visual disorders, and to improve the support of these children and their relatives/families.

Our experience, in daily practice with these children, tells us that they need to have a specific and individual approach that allows understanding, from a holistic point of view, of the impact of their disabilities and the strategies to follow.

Despite the lack of scientific rigorous knowledge on this topic, clinical and rehabilitation protocols have to be individual and ad-hoc, without any consensus, standard or validation. That is the reason why it is very necessary to work together on the development of a coherent and multidisciplinary protocol of assessment and rehabilitation at EU level. With the aim of standardising a European protocol to improve the skills of those professionals who are working with children with neurovisual disorders and to support this population in a more comprehensive way, this handbook col-

lects the different phases of the intervention as well as the necessary tools for implementation at each level.

This handbook is the product of a cooperative methodology amongst the different partners of the project, who had reached a consensus based on their expertise and best clinical and rehabilitation practices and counselling.

This handbook can be considered relevant and original not only for its transnationality but also because of its multiprofessional perspective. For this purpose, a methodology has been carried out in which professionals from different fields have participated: ophthalmologists, orthoptists, neuropsychologists, occupational therapists and optometrists among others. As the result of their collaborative work, through development and discussion their expertise and knowledge have been integrated in the assessment and rehabilitation of children with CVI.

Specific tools have been generated to facilitate the understanding of children of CVI and to provide adequate information that will enrich their evaluation, with the purpose of improving their interaction with society and their quality of life.

The main components of this handbook are:

- Questionnaire for Relatives and Others close to the Child: this questionnaire describes the observations concerning the activities of the child in daily life, to improve the comprehension of the impact of the disorders.

- Protocol of Assessment: this protocol is the process of a multidisciplinary evaluation to establish the profile and the needs of the child.

- Individual Passport: the structure of a simple and practical tool which gives information and advice (impact of disorders, needs, adaptation, etc.) for people who do not have specific knowledge concerning the child (care givers, social workers, etc.).

In addition, this handbook includes an appendix with a compilation of the main standardised tests that professionals can use in their daily practice and assessment.

Therefore the objective of this handbook is to provide support and guidance to those professionals who have to implement the experimental phase of this project as well as afterwards, and to those professionals who, being less familiar with neurovisual disorders, are involved with this kind of patient and who need to enrich and find new assessment tools.

On the basis of the definition of CVI established in the second American Conference on Paediatric Cortical Visual Impairment (2013), we will apply

the developed procedures to subjects with congenital or acquired brain-based visual impairment with onset in childhood, unexplained by an ocular disorder, and associated with unique visual and behavioural characteristics, who fulfil the following conditions:

- Children from 3 to 12 years old.
- Visual acuity from 0.05 to 0.5 with suspicion of CVI.
- Verbal cognitive level greater than 70.

Finally, this book will be complemented by a training course, which will allow professionals to complete the experimental phase to make sure that its implementation is rigorous and maintains similar standards in the different participating countries.

2.1 Web Map

Project description, its achievements or contact information together with other information can be found on the related website:

`http://www.cviproject.eu/`

Below, a graphical description of the content's structure hosted in the same web.

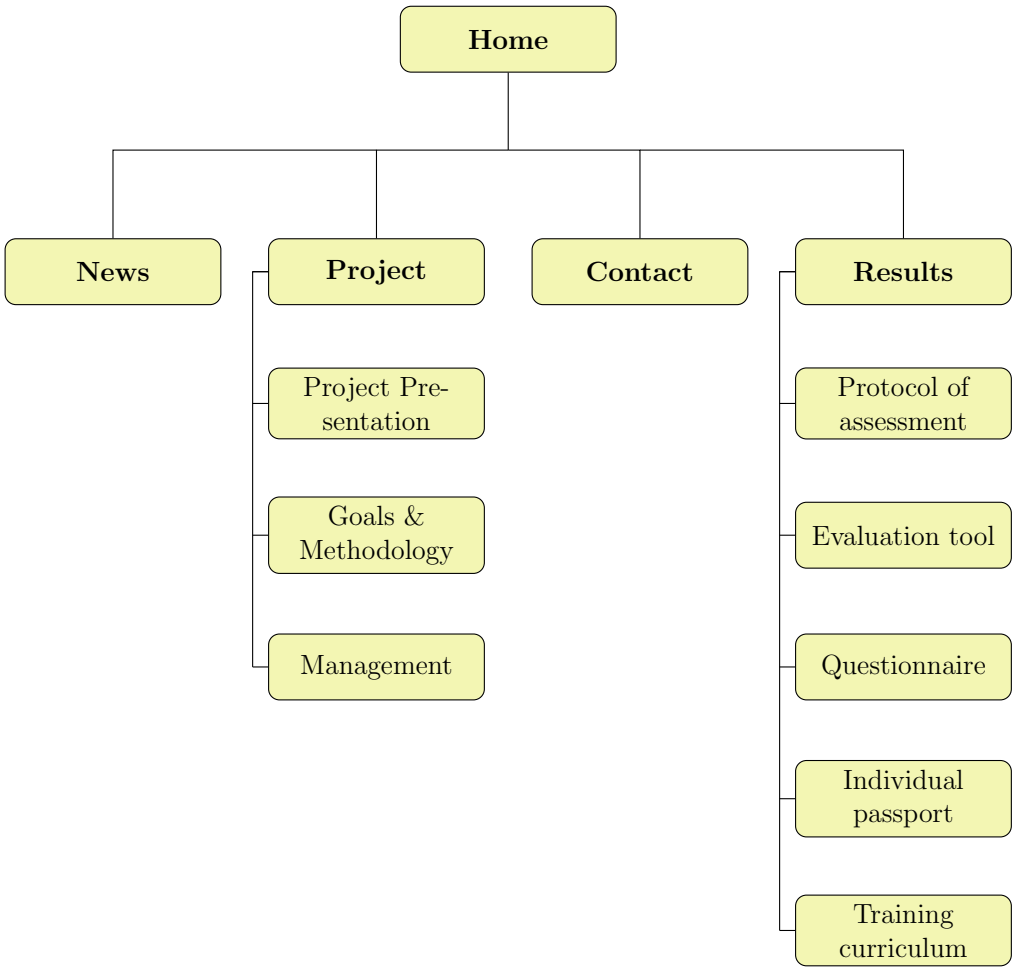

Figure 2.1: Website Map

2.2 General Process

As figure 2.2 shows, the protocol of the CVI project is divided in steps:

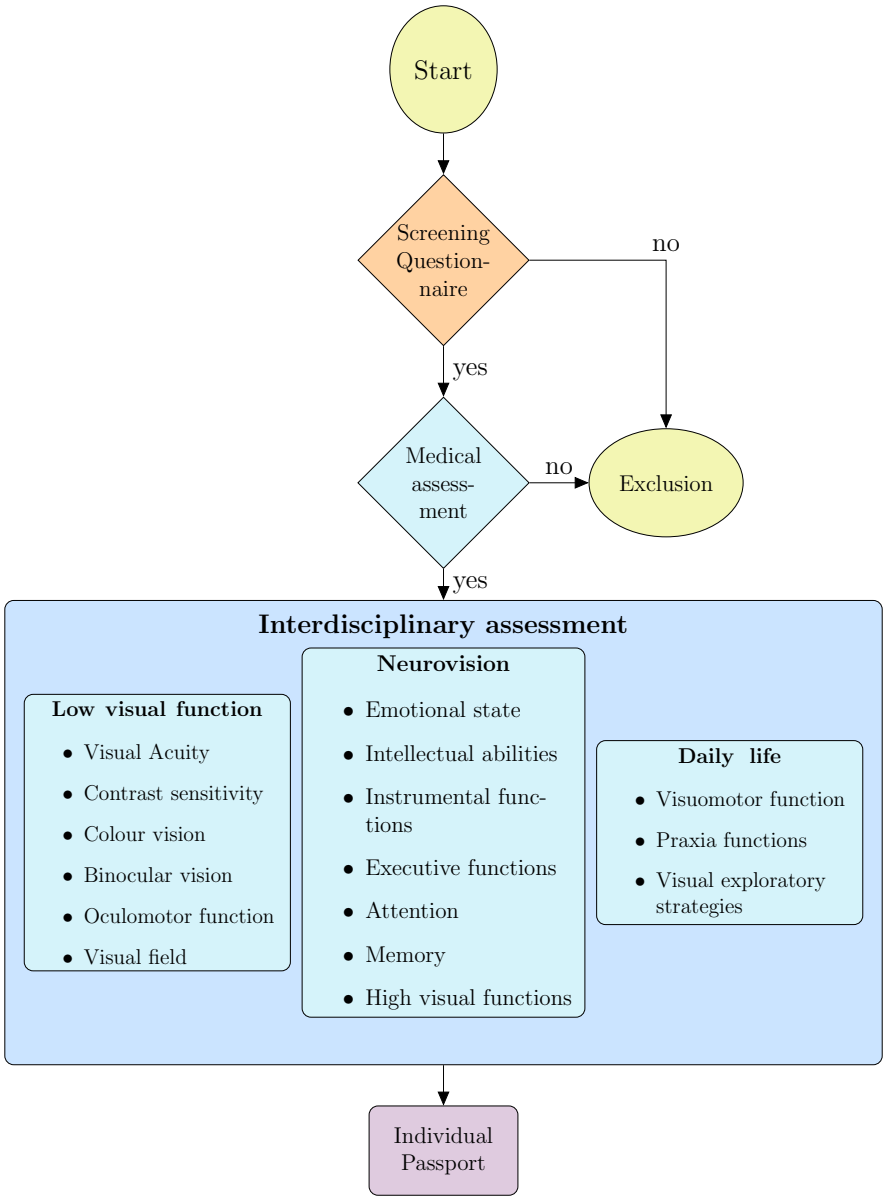

Figure 2.2: General process


C V I

Questionnaire 3

3.1 Introduction

"Erasmus+ questionnaire for relatives and carers" is the first part of the assessment protocol. It is a screening tool for our population (Table 1). If the results are positive, it indicates a possibility of CVI with low vision. In this case, a medical assessment will try to provide support for the diagnosis. An interdisciplinary assessment (neurovision, low vision and daily life) will be carried out afterwards.

The information about the specific needs of our population collected in the "Erasmus+ questionnaire for relatives and carers" is useful to complete the individual passport.

Figure 2.2 presents the general process and points out the place of the questionnaire.

As mentioned in the "CVI-Outcomes expected in the project", the questionnaire will comprise 4 different goals:

- Data collection concerning the case history of the child (age, school, etc.)
- Observations about the child in the family (life habits, behaviour, personal characteristics, etc.)
- Observations about the child in his/her environment, at school- and out of school (school skills, behaviour to work, behaviour in the groups of peers, etc.)
- Previous inventory of tools existing in each country and adaptation to the target group.

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3.2 Protocol of assessment overview

As figure 3.1 shows, this chapter is focused in the Screening Questionnaire.

1. **Screening questionnaire:** this questionnaire is the first step of the protocol. As explained in the Handbook this is a screening tool for our population and will be different dependent on the age of the participant. Based on the results from this questionnaire researchers will decide to include or not patients in the project. After taking the decision to include a patient, an informed consent must be signed.

2. **Medical assessment:** medical examinations are a fundamental step for the diagnosis of CVI with low vision. This examination will be performed in all patients included in the project to confirm the CVI with low vision diagnostic. It includes:

   - General anamnesis
   - Neuropaediatrician assessment
   - Paediatric ophthalmologist assessment

   If the diagnostic is confirmed, the protocol will be continued. If not, the patient will be excluded from the study.

3. **Evaluation:** this is the longest step of the protocol. It includes:

   - Low visual function evaluation
   - Neurovision evaluation
   - Daily life evaluation

   Detailed information concerning each of these phases can be consulted in the Handbook.

4. **Individual passport:** the CVI passport consists of three sections:

   - A manual for the practitioner
   - A form to be completed by parents and/or the patient
   - A keycard that identifies main impediments and possibilities of adjustment or compensation

   This tool will be created at the end of the previous phase, and will be delivered to the patient's family, care givers, tutors, etc. Detailed information regarding this issue can be consulted in the Handbook.

5. **Satisfaction survey:** a satisfaction survey will be completed by participants to conclude the study.

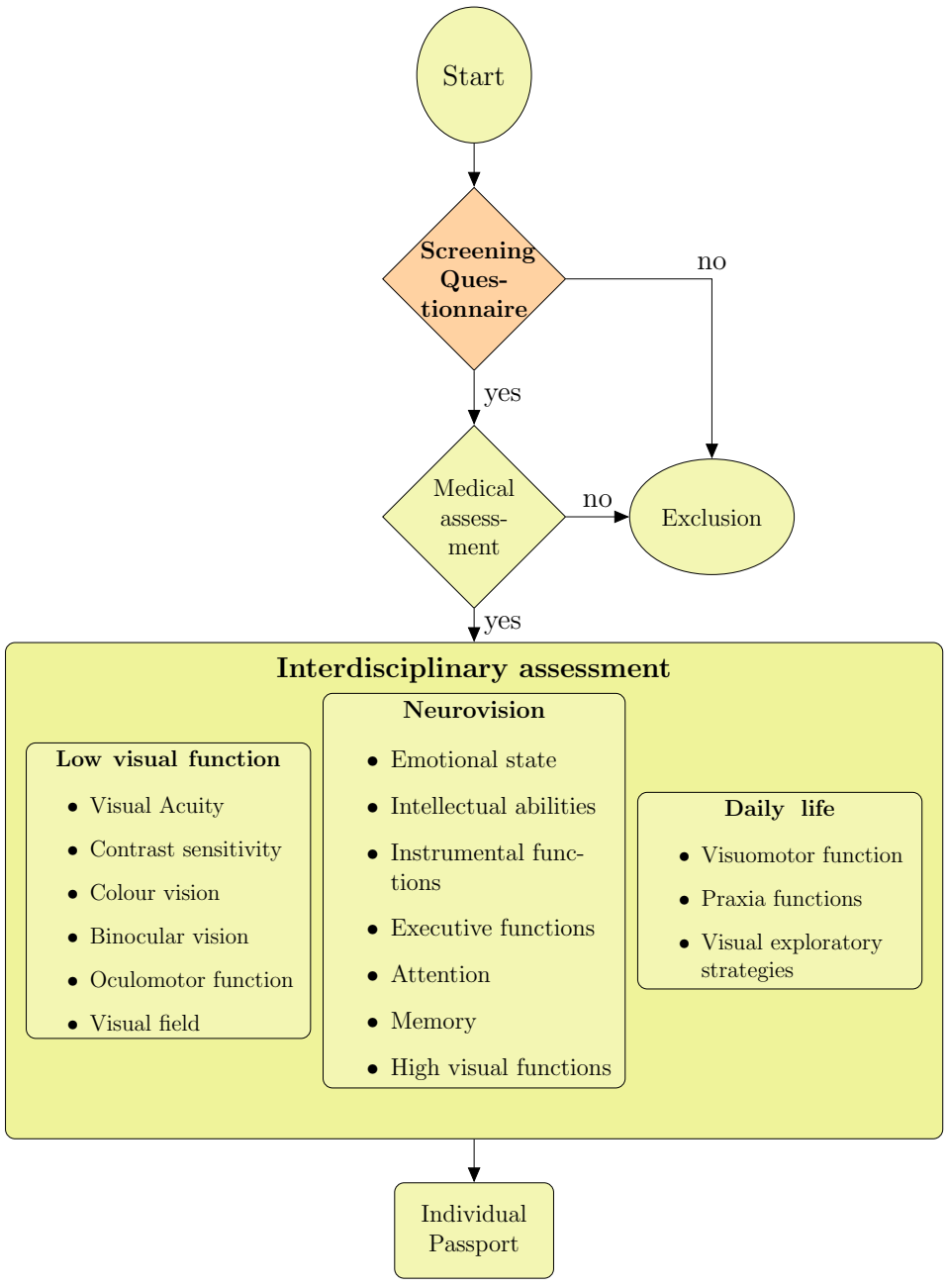


Figure 3.1: General process (Screening Questionnaire)

3.3 Methodology

In order to create a questionnaire adapted to our population, we have proceeded in four steps as illustrated in Figure 3.2. We will develop each part in the following pages.

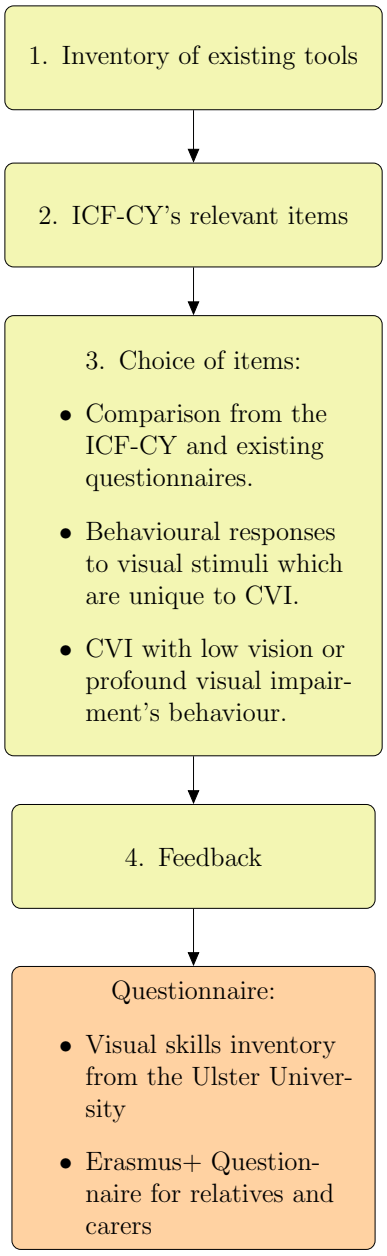


Figure 3.2: Summary of the methodology

Inventory of existing tools

Eight existing questionnaires, relevant to the target group, were collected and analysed.

Tool	Country
Visual skills inventory from the Ulster University (Dutton N. G.)	Ireland, U.K.
Questionnaire about the observation of young children's visual behavior ("Vragenlijst bij de observatie van het kijkgedrag van jonge kinderen") from Ganspoel	Belgium
PEDI-NL-CVI from Visio	Netherlands
Visual assessment in children with cerebral palsy: implementation of a functional questionnaire from Ferziger et al. [9]	Israel
Shortened visuospatial questionnaire from Cornoldi et al. [5]	Italy
Screening tool for dyspraxia at school ("outil de dépistage des troubles praxiques a l'ecole") from Clinique Churchill	Canada
Screening for cerebral visual impairment: value of a CVI questionnaire from Ortibus E. et al [33]	Belgium
Interview questions for parents [37] from Roman-Lantzy C. Boston, Massachusetts	USA

Table 3.2: Existing tools

The "Visual skills inventory" from the Ulster University seems to be the most relevant for our research because it is validated for our target group and is in English. Therefore, we decided to include it as the first part of the Erasmus+ questionnaire for relatives and carers. Nevertheless, it does not reach all the goals expected in the CVI-Outcomes. Therefore, a new questionnaire, which we will call Erasmus+ questionnaire for relatives and carers, with relevant items has been created (see 3. Choice from items).

ICF-CY items

In order to choose the relevant items to screen CVI children with low vision, the list of activities in the International Classification from Functioning, Disability and Health for Children and Youth (ICF-CY [32]) was analysed. Those that can be assessed with validated tools were included in the "Daily life assessment". Those that could not be assessed with validated tools are in the "Erasmus+ questionnaire for relatives and carers".

Six categories were selected in the ICF-CY's "Activities and participation: learning and applying knowledge, communication, mobility, self-care, interpersonal interactions and relationships and community, social and civic life.

ICF-CY's "Environmental factors" was also selected.

Choice of items

Items were chosen on one hand by comparing ICF-CY items and existing questionnaire and, on the other hand, by confronting unique CVI behaviour and specific low vision CVI behaviours.

Comparison of the ICF-CY items and existing questionnaires

The remaining relevant items in the ICF, with no validated assessment, are confronted (see below, Table 3.3) to the 8 existing questionnaires. X means that the item is mentioned in the questionnaire. For the function "Praxia", the items can be found in the I.C.F.: 1. Learning and knowledge translation, 5. Personal care and 9. Community, social and civic life.

ICF-CY	Items	ULSTER	GANSPOEL	PEDI-NL CVI	FERZIGER ET AL	CORNOLDI ET AL	CHURCHILL CLINIQUE	ORTIBUS E. ET AL	ROMAN-LANTZY
III. ACTIVITIES AND PARTICIPATION									
1.Learning and applying knowledge	1.1. Purposeful sensory experiences	x	x		x	x			
	1.2. Basic learning								
	Learning to write		x			x	x		
	Acquiring skills					x	x		
	1.3. Applying of knowledge								
	Reading	x	x				x		
	Writing		x			x	x		
3. Communication	3.2. Communications - creating :								
	Speech		x	x		x		x	
4. Mobility	4.3. Walking and moving :			x				x	
	Walking :								
	walking on different surfaces	x							
	walking around obstacles	x	x						
	Moving around in different locations :								

ICF-CY	Items	ULSTER	GANSPOEL	PEDI-NL CVI	FERZIGER ET AL	CORNOLDI ET AL	CHURCHILL CLINIQUE	ORTIBUS E. ET AL	ROMAN-LANTZY
	move around within the house	x							
	moving around within buildings other than home	x							
	moving around outside the home or other buildings	x							
5. Self-care				x	x	x	x	x	
7. Interpersonal interactions and relationships				x		x		x	
9. Community, social and civic life :	9.2. Recreation and leisure		x	x			x	x	x
IV. ENVIRONMENTAL FACTORS									
	i.e. : light, sound	x	x	x	x	x		x	x

Table 3.3: Confrontation between the relevant items in the ICF-CY and 8 existing questionnaire

Table 3.3 reveals that the "Visual skills inventory" from the Ulster University does not take into account some of the ICF's items. Therefore, these missing items will be in our questionnaire.

Behavioural responses to visual stimuli which are unique to CVI

There are several behavioural responses to visual stimuli which are unique to CVI. (Fazzi ,E. et al, Roman C. et al, Hall Lueck A., Dutton N. G.)

The table 3.4. is the confrontation of the behavioural responses which are unique to CVI and the "Visual skills inventory" from the Ulster University. X means that the item is mentioned in the questionnaire.

Behavioural responses to visual stimuli which are unique to CVI	**Ulster**
1. Light gazing and non-purposeful gaze	
2. Colour preference: especially for red or yellow	
3. Visual field preferences	x
4. Difficulties discriminating or interpreting complex visual patterns, arrays, and scenes	x
5. Better recognition of familiar objects than novel ones	
6. Attention to moving objects	x
7. Absence of visually guided reached	x
8. Visual latency	
9. Atypical visual reflexive responses	
10. Difficulty with distance viewing	x
11. Photophobia	
12. Poor visual attention	x
13. Variability in contrast	
14. Visual fatigue	

Table 3.4: Confrontation of the behavioural characteristics and the "Visual skills inventory" from the Ulster University

Table 3.4 reveals that the "Visual skills inventory" from the Ulster Uni-

versity does not take into account all the visual and behavioural characteristics. Therefore, these missing items will be in our questionnaire except for item "9. Absent or atypical visual reflexes" because it should be added in the ophthalmological anamnesis.

CVI with low vision or profound visual impairment's behaviours

Hall Lueck A., Dutton N. G. [25] have described specific behaviours of children with a CVI and a low vision or profound visual impairment.

These behaviours have been compared to the "Visual skills inventory" from the Ulster University. The following items were not mentioned in the Ulster's Visual Skills Inventory. They have been added in the "Erasmus+ questionnaire for relatives and carers":

Item	Description
Hearing/auditory screening	Difficulty hearing, locating and interpreting the spoken word or environmental sounds, especially in noisy situations
Adaptive behaviours	Unusual behaviours accompany task performance e.g. eye turn, hand waving...
Auditory processing	not knowing where voice is coming from...
Blind sight evaluation	intermittently noticing stimuli brought in from periphery...
Reading	not fluent when text is matched to visual acuity, reading is enhance by occluding adjacent test
Mathematics	needing graph paper of appropriate size and line thickness or else numbers can't be aligned otherwise
Arts and crafts	difficulty mentally rotating, invoking and creating imagery from memory for artwork or to copy from images or real life
Assisting technology	can benefit from alternative means of access to curricula, materials, environment
Other school subject	varies with task to be performed
Understanding CVI	child does not understand that behaviours are different from peers

Table 3.5: Added behaviours

Feedback

The "Erasmus+ questionnaire for relatives and carers" was submitted to all the partners and different items were added or deleted.

3.4 Manual for practitioners

As stated in the introduction, the "Erasmus+ questionnaire for relatives and carers" is the first step of the assessment protocol: it is a screening tool for our population, those suspected of having CVI associated with low vision. The "Erasmus+ questionnaire for relatives and carers" will also help clinicians to reveal specific needs from our population which will complete the individual passport. The Questionnaire consists of a list of items that the parents and a professional (care giver, psychologist, etc.) have to complete by mentioning if the item occurs "always to never" (on a 5 points Likert scale)

The questionnaire for the present project includes the following 2 parts: the visual skills inventory, from Ulster University, and the Erasmus+ Questionnaire.

Visual skills inventory from the Ulster University

This inventory can be found here[1]. There are 2 inventories for different age groups: 4 to 8 year olds and 9 to 12 year olds. For the score, children with typical vision tend to have responses from "never" with 2 or 3 responses from "rarely", except for questions 37 and 38 for the 4 to 8 year olds and questions 39 and 40 for the 9 to 12 year olds. (Hall Lueck A., Dutton N. G.) The inventory allows to seek evidence of (Hall Lueck A., Dutton N. G.):

[1] http://biomed.science.ulster.ac.uk/vision/Visual-Skills-Inventories.html

	4 to 8 years old	**9 to 12 years old**
1. A visual field impairment or impaired visual attention on one or both sides	Questions 1 to 13	Questions 1 to 12
2. Impaired perception of movement	Questions 14 to 18	Questions 13 to 18
3. Difficulty handling the complexity of a visual scene	Questions 19 to 27	Questions 19 to 29
4. Impairment of visually guided movement of the body and further evidence of visual field impairment	Questions 28 to 34 b)	Questions 30 to 36 b)
5. Impairment of visually guided movement of the upper limbs	Questions 35 and 36	Questions 37 and 38
6. Impaired visual attention	Questions 37 to 40	Questions 39 to 42
7. Behavioural difficulties associated with crowded environments	Questions 41 to 44	Questions 43 to 45
8. The ability to recognise what is being looked at and to navigate	Questions 45 to 51	Questions 46 to 54

Table 3.6: Sections of the Visual skills inventory by abilities

Erasmus+ questionnaire for relatives and carers

Depending on the age of the child, the experimenter will choose the version for 3 to 5 years old or the one for 6 to 12 years old.

The questions are about:

		3 to 5 years old	**6 to 12 years old**
1.Learning and applying knowledge	Learning and applying knowledge	Questions 1 to 4	Questions 1 to 7
	Communication	Questions 5 to 7	Questions 8 to 10
	Self-care	Questions 8 and 9	Questions 11 and 12
	Interpersonal interactions and relationships	Questions 10 and 11	Questions 13 and 14
	Community, social and civic life	Questions 12 and 13	Questions 15 and 16
Behaviours		Questions 14 to 16	Questions 17 to 19
		Question 16 is about blindsight	Question 19 is about blindsight
Compensatory strategies		Questions 17 to 22. Question 19 is about eccentric viewing	Questions 20 to 25. Question 22 is about eccentric viewing
Facilitators		Questions 23 to 30. Question 29 is about visual latency	Questions 26 to 34 Question 32 is about visual latency
Others		Questions 31 to 34	Questions 35 to 38

Table 3.7: Sections of the Questionnaires by abilities

3.5 Erasmus+ questionnaire for relatives and carers (3-5 years old)

General information	
Date:	
Child's name:	
Date of birth of the child:	
Interview with (occupation):	
Completed by:	

Does the child...	Always	Often	Sometimes	Rarely	Never		Not applicable
01. make use of the available space when drawing on a blank page?							
02. see what is written or drawn on the blackboard?							
03. use correctly his/her tools (e.g.: ruler, scissors) in classroom activities?							
04. visual performance tends to vary?							
05. make eye contact with you?							
06. look at you while talking during a conversation?							
07. say when an activity is difficult for him/her?							
08. engage in good conversation appropriated to his/her age?							

	Always	Often	Sometimes	Rarely	Never		Not applicable
Does the child...							
09. [By her/him-self] undress correctly (i.e.: take off coat, shirt, pants)?							
10. [By her/him-self] get dressed correctly (i.e.: put on his/her clothes)?							
11. "easily" interact with peers?							
12. "easily" interact with adults?							
13. avoid games/activities because of visual difficulties?							
14. recognise better familiar objects over novel ones?							
15. spend long periods of time gazing at light?							
16. fixate somewhere for a long period when no target is present?							
17. unconsciously objects located in his blind field? (blindsight)							
18. get closer to the worksheets?							
19. turns or tilts his/her head when looking in front of him?							
20. looks the object slightly away instead of looking it in front (eccentric viewing)?							
21. use more tactile information rather than visual?							
22. listen more rather than looking?							
23. can localize the source of a sound?							
24. read if the text is enlarge?							

	Always	Often	Sometimes	Rarely	Never		Not applicable
Does the child...							
25. see if some part of the worksheet is hidden?							
26. see/read easier with more lighting (i.e.: a reading lamp)?							
27. see/read easier with a good contrast?							
28. see/read easier with a book-stand?							
29. perform a task in a quiet environment?							
30. need more time to respond after visual stimuli (visual latency)?							
31. pay attention to objects of certain colours? If so, which colour:							
32. have an aversion to light?							
33. have difficulties walking in a dim light?							
34. have a visual fatigue after a visual activity?							
35. can explain his/her vision?							

Table 3.8: Erasmus+ questionnaire for relatives and carers (3-5 years old)

3.6 Erasmus+ questionnaire for relatives and carers (6-12 years old)

General information	
Date:	
Child's name:	
Date of birth of the child:	
Interview with (occupation):	
Completed by:	

	Always	Often	Sometimes	Rarely	Never		Not applicable
Does the child...							
01. make use of the available space when drawing on a blank page?							
02. confuse letters that look similar (e.g.: p, q, d, b)?							
03. fill in a blank on the correct line in a reading worksheet?							
04. write numbers in column correctly?							
05. see what is written or drawn on the blackboard?							
06. use correctly his/her tools (e.g.: ruler, scissors) in classroom activities?							
07. visual performance tends to vary?							
08. make eye contact with you?							
09. say when an activity is difficult for him/her?							

	Always	Often	Sometimes	Rarely	Never		Not applicable
Does the child...							
10. engage in good conversation appropriated to his/her age?							
11. [By her/him-self] undress correctly (i.e.: take off coat, shirt, pants)?							
12. [By her/him-self] get dressed correctly (i.e.: put on his/her clothes)?							
13. “easily” interact with peers?							
14. “easily” interact with adults?							
15. avoid games/activities because of visual difficulties?							
16. recognise better familiar objects over novel ones?							
17. spend long periods of time gazing at light?							
18. fixate somewhere for a long period when no target is present?							
19. Unconsciously locates objects which are in his blind field? (blindsight)							
20. get closer to the worksheets?							
21. turns or tilts his/her head when looking in front of him?							
22. looks the object slightly away instead of looking at it in front (eccentric viewing)?							
23. use more tactile information rather than visual?							
24. listen more rather than looking?							

	Always	Often	Sometimes	Rarely	Never		Not applicable
Does the child...							
25. can localize the source of a sound?							
26. read if the text is enlarged?							
27. read if the part of the text is hidden?							
28. see/read easier with more lighting (i.e.: a reading lamp)?							
29. see/read easier with a good contrast?							
30. see/read easier with a book-stand?							
31. perform a task in a quiet environment?							
32. need more time to respond after visual stimuli (visual latency)?							
33. pay attention to objects of certain colours? If so, which colour:							
34. use assisted technology (e.g.: software program for reading or writing, talking watch)							
35. have an aversion to light?							
36. have difficulties walking in a dim light?							
37. have a visual fatigue after a visual activity?							
38. can explain his/her vision?							

Table 3.9: Erasmus+ questionnaire for relatives and carers (6-12 years old)


C V I

Protocol of assessment 4

35

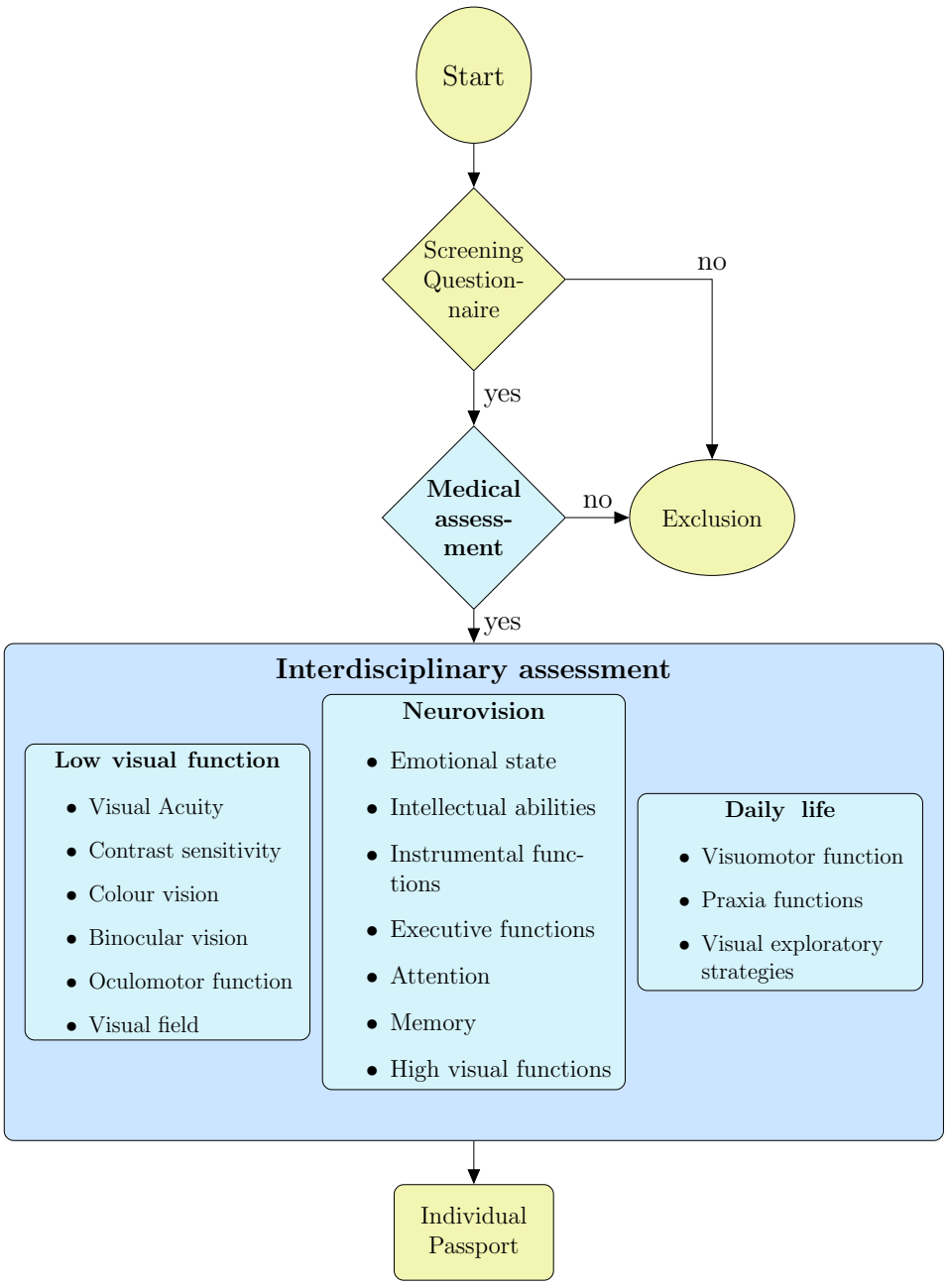


Figure 4.1: General process (Protocol of Assessment)

4.1 Medical assessment

Introduction

The global protocol starts when relatives, care givers or professionals suspect the presence of CVI and have responded to the Erasmus+ questionnaire and the Visual Skills Inventory from Ulster University. If it indicates the possibility of CVI, the procedure confirming a diagnostic will start. Medical examinations are a fundamental first step for the diagnosis of CVI with low vision. The medical involvement must be multi-disciplinary and carried out collaboratively by a neuropaediatrician and a paediatric ophthalmologist. This part will precise the content of a medical assessment which is essential in case of CVI suspicion.

Medical examinations

The medical assessment consists of three main parts:

1. General anamnesis
2. Neuropaediatrician assessment
3. Paediatric ophthalmologist assessment

General anamnesis

The general anamnesis aims to collect information about :

- Child's family history
- Child's personal information: development during pregnancy, delivery (at what point of the pregnancy, weight at birth, size of skull, APGAR score (at 0, 5 and 10 minutes) (see table 4.2)
- Perinatal Period:
  - Events afterwards: Infection? Stroke? Hospitalization? Period in Intensive Care? Epilepsy(+ description)
  - Additional examinations: Neurophysiological (EEG-Electroencephalography) or by image (cerebral ultrasound examination, MRI-Magnetic Resonance Image, BCT-Brain Computed Tomography, etc.)
- Development of the child:

APGAR Test Scoring				
Indicator		0 Point	1 Point	2 Point
A	Activity (muscle tone)	Absent	Flexed arms and legs	Active
P	Pulse	Absent	<100 bpm	>100 bpm
G	Grimace (Reflex irritability)	Floppy	Minimal response to stimulation	Prompt response to stimulation
A	Appearance (Skin colour)	Blue pale	Pink body and blue extremities	Pink
R	Respiration	Absent	Slow and irregular	Vigorous cry

Table 4.2: APGAR Test Scoring

  - Has he/she had surgery procedures? Derivation of Hydrocephaly? Others?
  - Has he/she been a victim of (a) cerebral trauma? If yes: at what age? Was he/she in a coma? For how long? Have cerebral lesions been identified?
  - Any other medical event?
  - Psycho-motor development: At what age appeared: ocular fixation, ocular pursuit, the first smile, first words, sitting, standing, first steps
  - Education: Mainstream or Special School? Learning disability?
- Other : are there any concerns about the child's vision? If so, what are they?

Neuropediatrician assessment

The neuropaediatrician will examine the child: weight, height, diameter of skull; looking at the cranial nerves, tonus? Reflexes? Abnormal movements? If the child has cerebral palsy (CP), in order to appreciate its degree of severity, the following classifications will be used[1]:

- GMFCS: Gross Motor Function Classification System.

[1]Figures in Table 4.3 have been taken from `https://www.google.be/search?q=GMFCS&client=firefox-b-ab&source=lnms&tbm=isch&sa=X&ved=0ahUKEwjSrY6OrojUAhXCPRQKHZb_AdoQ_AUICigB&biw=1920&bih=876#imgrc=gVCQI1LEJ2VlOM`

- MACS: Manual Ability Function Classification System.
- CFCS: Communication Function Classification System.
- EDACS: Eating and Drinking Ability Classification System.

In addition, the following items will be noted: the resulting presence of epilepsy will be noted and its type, the medical treatment of the child, any other resulting complementary examinations which have been carried out: EEG? Hearing assessment? Scanner or cerebral MRI.

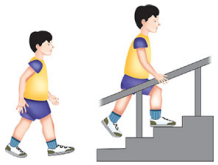
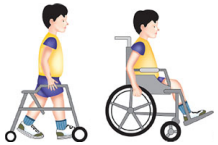
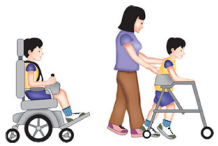
Level	GMFCS	MACS	CFCS	EDACS
I	 Walk without limitations	Handles objects easily and successfully	Sends and receives information with familiar and unfamiliar partners effectively and efficiently	Eats and drinks safe and efficiently
II	 Walk with limitations	Handles most objects but with somewhat reduced quality and/or speed of achievement	Sends and receives information with familiar and unfamiliar partners but may need extra time	Eats and drinks safely but with some limitations to efficiency
III	 Walks using a hand-held mobility device	Handles objects with difficulty; needs help to prepare and/or modify activities	Sends and receives information with familiar partners effectively, but not with unfamiliar partners	Eats and drinks with some limitations to safety, there may be limitations to efficiency
IV	 Self mobility with limitations; may use powered mobility	Handles a limited selection of easily managed objects in adapted situations	Inconsistently sends and/or receives information even with familiar partners	Eats and drinks with significant limitations to safety
V	 Transported in a manual wheelchair	Does not handle objects and has severely limited ability to perform even simple actions	Seldom sends and receives information effectively even with familiar partners	Cannot eat or drink safely, tube feeding, maybe considered to provide nutrition

Table 4.3: Classification of cerebral palsy

Paediatric ophthalmologist assessment

The paediatrician ophthalmologist will examine the child by reviewing specific ophthalmological activities and history : previous examinations, previous refractions, wearing glasses, strabismus or nystagmus treatments, abnormality of the photomotor reflex for one eye and the other, premature retinopathy and any other eye pathology.

The ophthalmological examination will include:

- Study of reflexes of the eye pupils (relative afferent pupillary defect, RAPD, or Marcus Gunn pupil test); pupillary reflex near vision.
- Refraction: after use of cycloplegic drugs (cyclopentolate or Atropine 0,5%) by retinoscopy or autorefraction.
- Slit lamp exam: looking at cornea, iris, lens, anterior chamber, any abnormality?
- Fundoscopy: by direct or indirect ophthalmoscopy looking at the retina, the vessels and the optic disk.
- Tonometry: if possible by air or applanation tonometer

Conclusions

This medical information will allow:

- Suspecting and/or pointing out objectively the presence of a cerebral lesion.
- Establishing the presence or not of associated ocular abnormalities.

Localisation and extent of the cerebral lesion(s) are important elements for understanding the clinical picture. The same applies for associated ocular problems. After these medical exams, the diagnostic approach should be pursued, within a multidisciplinary team using tests measuring Low Visual Function, Neurovision and Daily life.

4.2 Low visual function

Before speaking about CVI, it is very important to know what "low visual function" is, both the visual sensory functions and the oculomotor sections.

The evaluation of low visual functions is a part of the Protocol of Assessment. It is very important to assess visual functions (visual sensory and oculomotor functions) before functional vision and neurovision, in order to keep them in mind for the rest of the evaluation and for its interpretation.

In early stages of the project, each partner presented the tools they were using and then we chose the most relevant ones for our target population and therefore for the project.

We have gathered several tests for each function. They are not meant to use them all but to choose one per each function, except for the evaluation of the visual acuity [23, 25]. For that functionality, it is important to use the different optotypes ("E, symbols, images) as those may give indications for functional vision as well as for their presentation (simple or linear).

Some of those tests are standardised while others are based on clinical observations.

Assessment tools

The criteria to carry out these tests is:

- The relevance of the tests to the project:
  1. Children from 3-12 years old
  2. Visual acuity 0.05-0.5 with suspicion of CVI
  3. Verbal cognitive level > 70
- The standardisation of the test
- The international authenticity of the test

For the examination of the low visual functions we divided our population into two categories: one for children from 3 to 6 years old and one for children from 6 to 12 years old. The following table summarizes the different functions that will be assessed in the "low vision" section.

Visual acuity: it is very important that we use E AND symbols / numbers AND pictures (see clinical remarks). Visual acuity for each optotype is measured binocular and isolated. In order to reduce the test time, only the optotype which allows the best visual acuity is measured linear and crowded. Monocular acuity is only measured on the single optotype which

Function	Specific function
Visual acuity	Recognition acuity
	Resolution acuity
Contrast sensitivity [23]	Recognition acuity
	Resolution acuity
Colour vision [10, 23]	Arrangement test
	Pseudo isochromatic
Binocular vision [23]	Stereopsis
	Convergence
	Accommodation
	Ocular deviation
Oculomotor function [23, 25]	Version (distance vision and near vision)
	Duction
	Fixation
	Saccadic eye movement
Visual field [23]	Confrontation
	Kinetic perimetry

Table 4.4: Functions to be assessed

allows the best visual acuity. It is also important to measure the single and linear acuity to calculate the crowding ratio (by dividing the single symbol acuity by the linear symbols acuity. If the result is equal or superior to 2, the result is abnormal)

Contrast sensitivity: we'll use lea low contrast [24] if visual acuity is more than 0.1 and if it's less we'll use hiding heidi [24].

Colour vision: we'll use pseudo isochromatic tests if contrast sensitivity [25] is OK and if there is a problem with contrast vision we'll use the arrangement test.

Binocular vision: Except for the stereopsis test, all the tests of specific functions are objective tests.

Mobility: there is no standardised test for children from 3 to 5 years old. Some specific functions will be tested only with objective tests.

Visual field: confrontation [21, 25, 38] is always objective and better with 2 examiners.

For each function and specific function, we propose either one or several tests. Our preference is the first one (1/), but if the examiner doesn't have the first one, he can choose the second (2/) or the third (3/).

Tests for visual acuity

Visual Acuity	
Specific function	Recognition acuity
Name of the test / subtest	1/Tumbling E single, linear
Age (years)	3-12
Standardisation	Validation
Description of the task	1/Angular test: We ask the child to tell us or show us in which direction the bars of the E
Clinical remarks	Measure the need for light
Test duration	10 min

Table 4.5: Tumbling E single test

Visual Acuity	
Specific function	Recognition acuity
Name of the test / subtest	2/ Lea Symbols [13] single, linear and single crowded test for distance / single and linear test for near (25% crowded linear test for near could also be administered, if possible)
Age (years)	3-6
Standardisation	Validation
Description of the task	2/It can be used to measure the resolution of visual pathways in an amblyopic or visually impaired child. For children with less than 0,1 visual acuity we can use Lea Symbols/Numbers at a closer distance (less than 3 m) or use a Lea Symbols/Numbers Low Vision Test (at 3 m)
Clinical remarks	Comparison between results from 1/ 2/ and 3/; if the visual acuity measured with "E" is significantly higher than with pictures or symbols, we should suspect agnosia; if the visual acuity with "E" is lower we can suspect a visual spatial problem
Test duration	10 min

Table 4.6: Lea Symbols test

Visual Acuity	
Specific function	Recognition acuity
Name of the test / subtest	2/ Lea Numbers Single and linear test for distance / linear and 25% crowded linear test for near
Age (years)	6-12
Standardisation	Validation
Description of the task	2/It can be used to measure the resolution of visual pathways in an amblyopic or visually impaired child. For children with less than 0,1 visual acuity we can use Lea Symbols/Numbers at a closer distance (less than 3 m) or use a Lea Symbols/Numbers Low Vision Test (at 3 m)
Clinical remarks	
Test duration	10 min

Table 4.7: Lea Numbers test

Visual Acuity	
Specific function	Recognition acuity
Name of the test / subtest	3/ Kay Picture Test [20] A) Low Vision Book Set (single pictures), B) Single Crowded Book, C) Linear Crowded Book
Age (years)	A) and B) 18 months+ 3/ C) 30 months+
Standardisation	Validation
Description of the task	A) The Low Vision Book Set is specifically targeted to testing those with poor vision. It has single, uncrowded picture presentation in twelve LogMAR sizes, which, at three metres is from 1.3 to 0.2 plus a near vision test and matching card
Clinical remarks	
Test duration	5 min

Table 4.8: Kay Picture test

Visual Acuity	
Specific function	Resolution acuity
Name of the test / subtest	1.1./ Teller Acuity Cards [39]
Age (years)	4 months−3 years
Standardisation	Validation
Description of the task	1/ The infant or child detects the presence of parallel lines of decreasing width, a task simpler than the recognition of optotypes. Preferential looking is used. 1.1./ present in form of a rectangular card, the examiner is behind a screen. The patient can only see the card
Clinical remarks	Resolution acuity tends to overestimate visual acuity. The difference between resolution and recognition acuity can be very large in CVI.
Test duration	10 min

Table 4.9: Teller Acuity test

Visual Acuity	
Specific function	Resolution acuity
Name of the test / subtest	1.2./ Lea Gratings
Age (years)	4 months−3 years
Standardisation	Validation
Description of the task	1.2./ present in form of a paddle
Clinical remarks	More relevant in case of visual field impairment.
Test duration	5 min

Table 4.10: Lea Gratings test

Visual Acuity	
Specific function	Resolution acuity
Name of the test / subtest	2/ Cardiff Acuity Test [47]
Age (years)	1-3
Standardisation	Standardised
Description of the task	2/ present in form of rectangular cards, picture of an object is located on the upper or the lower part of the card. Preferential looking is used
Clinical remarks	2/ We are measuring resolution visual acuity if a child only looks or points at the picture of an object (preferential looking) even when a child names the picture, we are still measuring resolution.
Test duration	10 min.

Table 4.11: Cardiff Acuity Test

Tests for contrast sensitivity

Contrast Sensitivity	
Specific function	
Name of the test / subtest	1/ Lea Symbols
Age (years)	3–6
Standardisation	1/Validation
Description of the task	1/Recognition tests. In order to make a valid comparison between the visual acuity and contrast sensitivity, it is important to use the same set of optotypes in tests. For the purpose of this project, contrast sensitivity should be measured at 10% and 2,5% contrast
Clinical remarks	1/Both tests have 2 types: Flipchart (10M sized optotypes of different contrast levels) or translucent tests for lightboxes (different optotype sizes for each contrast). Reporting: write down the contrast value and visual acuity at that contrast.
Test duration	5 min.

Table 4.12: Lea Symbols test

Contrast Sensitivity	
Specific function	
Name of the test / subtest	1/ Lea Numbers
Age (years)	6−12
Standardisation	1/Validation
Description of the task	1/Recognition tests. In order to make a valid comparison between the visual acuity and contrast sensitivity, it is important to use the same set of optotypes in tests. For the purpose of this project, contrast sensitivity should be measured at 10% and 2,5% contrast
Clinical remarks	1/Both tests have 2 types: Flipchart (10M sized optotypes of different contrast levels) or translucent tests for lightboxes (different optotype sizes for each contrast). Reporting: write down the contrast value and visual acuity at that contrast.
Test duration	5 min.

Table 4.13: Lea Numbers test

Contrast Sensitivity	
Specific function	
Name of the test / subtest	2/ Cambridge Low contrast Gratings
Age (years)	3–12
Standardisation	2/Validation
Description of the task	2/ Detection test. This can be used when the visual acuity is measured with gratings it gives information about the visibility of long low contrast lines in the environment. If the child's visual acuity is less than 0,1 (1,0 LogMAR), it is difficult to use Lea Symbols/Numbers then Cambridge Low Contrast Gratings [31, 45] can give a rough assessment of contrast sensitivity
Clinical remarks	2/ It can be used if a child's visual acuity is below 0,1 (1,0 LogMAR). The test distance is kept within the visual sphere of the child, shorter than the originally recommended 6 meters
Test duration	5 min.

Table 4.14: Lea Numbers test

Contrast Sensitivity	
Specific function	
Name of the test / subtest	3.1./Hiding Heidi
Age (years)	4 months−12 years
Standardisation	3/Validation
Description of the task	3.1./ The expression of the face in HH card is made up of very slightly contrasting shadows and barely visible changes in the contours of the mouth and the eyes. Preferential looking is used
Clinical remarks	3.1./ It can be used if a child's visual acuity is below 0,1 (1,0 LogMAR). Reporting: write down the distance used and the lowest contrast level seen by a child at that distance
Test duration	5 min.

Table 4.15: Hiding Heidi test

Contrast Sensitivity	
Specific function	
Name of the test / subtest	3.2./ Cardiff Contrast Sensitivity Test
Age (years)	1−3
Standardisation	
Description of the task	3.2./ Preferential looking is used. It is suggested to use this test if the visual acuity is tested with the Cardiff Acuity Test. It has norms for age groups
Clinical remarks	
Test duration	10 min.

Table 4.16: Cardiff Contrast Sensitivity Test

Tests for colour vision

Colour Vision	
Specific function	Arrangement tests
Name of the test / subtest	1/Farnsworth 15 [8] or 2/Panel 16 [16]
Age (years)	5+
Standardisation	Validation
Description of the task	This type of colour blindness tests are based on a set of coloured plates or discs which have to be arranged in the correct order. Colourblind people will have difficulties arranging the given colours and will make mistakes. Based on these mistakes and the resulting confusion vector, the type of your colour blindness and also its severity can be calculated
Clinical remarks	If there is a contrast sensitivity problem
Test duration	1/ 10 min. – 2/ 8 min.

Table 4.17: Farnsworth 15 and Panel 16 Tests

Colour Vision	
Specific function	Pseudo isochromatic
Name of the test / subtest	1/ Ishihara [18] 2/ Babydalton 3/ CVTME [6]
Age (years)	1/3−12 2/3+ 3/3+
Standardisation	Validation
Description of the task	This test is only made to check for red-green colour blindness, Only one of these tests can be used, because they are similar
Clinical remarks	If there is no contrast sensitivity problem
Test duration	1/ 10 min. 2/ 3 min. 3/ 3 min.

Table 4.18: Isihara, Babydalton and CVTME Tests

Tests for binocular vision

Binocular Vision	
Specific function	Stereopsis
Name of the test / subtest	Lang I and II
Age (years)	3−12
Standardisation	Validation
Description of the task	LANG STEREOTEST is an easy to use and designed test for the detection of stereoscopic vision problems in Children. Two versions are available, which differ only in the three-dimensional (3D) elements to be recognised
Clinical remarks	
Test duration	2 min.

Table 4.19: Stereopsis Test

Binocular Vision	
Specific function	Convergence
Name of the test / subtest	Penlight sticks
Age (years)	3–12
Standardisation	Objective method
Description of the task	Convergence is the simultaneous inward movement of both eyes toward each other, usually in an effort to maintain single binocular vision [25] when viewing an object
Clinical remarks	
Test duration	1 min.

Table 4.20: Convergence Test

Binocular Vision	
Specific function	Accommodation
Name of the test / subtest	1/ RAF 2/ Dynamic retinoscopy 3/ Flippers +/− 1 or 2
Age (years)	3–12
Standardisation	
Description of the task	
Clinical remarks	
Test duration	10 min

Table 4.21: Accommodation Tests

Binocular Vision	
Specific function	Ocular deviation
Name of the test / subtest	Cover test
Age (years)	3–12
Standardisation	Objective method
Description of the task	Single and alternate cover test. The presence of ANY movement on a single cover test indicates a tropia. The alternate cover test is the most dissociative cover test and measures a total deviation, including the tropic plus the phoric/latent component
Clinical remarks	
Test duration	2 min

Table 4.22: Cover Test

Binocular Vision	
Specific function	Ocular deviation
Name of the test / subtest	Corneal reflection (Hirschberg test)
Age (years)	3–12
Standardisation	Objective method
Description of the task	Observing the corneal reflection of a pointed light source placed at 50cm, facing the patient, at the height of his eyes
Clinical remarks	
Test duration	2 min.

Table 4.23: Hirschberg Test

Tests for oculomotor function

Oculomotor function	
Specific function	Version (distance vision and near vision)
Name of the test / subtest	Target
Age (years)	3–12
Standardisation	Objective method
Description of the task	The versions represent the conjugate movements of the two eyes in the same direction. The study of the versions is most easily performed in near vision by setting within 8 diagnostic directions of gaze, eccentric 30 degrees. The versions can also be studied, less easily, in far vision: they are in general realised by turning the head of the subject who always fixes on the same point.
Clinical remarks	
Test duration	3 min.

Table 4.24: Version Test

Oculomotor function	
Specific function	Duction
Name of the test / subtest	Target
Age (years)	3–12
Standardisation	Objective method
Description of the task	Eye movement seen in one eye at a time, in the diagnostic positions of gaze to study: • The motor properties of each eye • The limits of the ductions with respect to the normal marks
Clinical remarks	
Test duration	3 min.

Table 4.25: Duction Test

Oculomotor function	
Specific function	Fixation
Name of the test / subtest	Fixation sticks (minimum visible) or Penlight
Age (years)	3–12
Standardisation	Objective method
Description of the task	Point to be fixed, the size of which varies according to the visual acuity of the patient. Stability of fixation is observed while the child is fixating on a small object or picture
Clinical remarks	Highest possible contrast, different sizes
Test duration	2 min.

Table 4.26: Fixation Test

Oculomotor function	
Specific function	Pursuit
Name of the test / subtest	NSUCO
Age (years)	5–12
Standardisation	Standardised
Description of the task	The NSUCO allows a standardised assessment, and consequently quality of the pursuit and saccadic eye movements on four dimensions: aptitude, precision, cephalic or body compensation
Clinical remarks	
Test duration	2 min.

Table 4.27: NSUCO Test

Oculomotor function	
Specific function	Pursuit
Name of the test / subtest	Fixation sticks
Age (years)	3–12
Standardisation	Objective method
Description of the task	
Clinical remarks	
Test duration	2 min.

Table 4.28: Fixation sticks Test

Oculomotor function	
Specific function	Saccadic eye movement
Name of the test / subtest	DEM [11]
Age (years)	6−14
Standardisation	Standardised
Description of the task	Small and long saccades are observed
Clinical remarks	Qualitative analysis. Possible if AV $>$ 0.1
Test duration	2 min.

Table 4.29: DEM Test

Oculomotor function	
Specific function	Saccadic eye movement
Name of the test / subtest	NSUCO [11]
Age (years)	5−12
Standardisation	Standardised
Description of the task	Small and long saccades are observed
Clinical remarks	
Test duration	2 min.

Table 4.30: NSUCO Saccadic Test

Oculomotor function	
Specific function	Saccadic eye movement
Name of the test / subtest	Fixation sticks, small objects [11]
Age (years)	3–5
Standardisation	Objective method
Description of the task	
Clinical remarks	
Test duration	

Table 4.31: Fixation sticks, small objects Test

Visual Field

Visual Field	
Specific function	Confrontation
Name of the test / subtest	Toys; Lea paddle; Stycar balls
Age (years)	3–12
Standardisation	Objective method
Description of the task	With the examiner seated directly across from the patient, the patient should direct their gaze to the corresponding eye of the examiner. The testing itself can be performed using stationary or moving targets (Toys or Lea Paddle)(to start with diameter 40 mm; there are age norms and literature comparing the results with conventional methods like Goldmann).[17]
Clinical remarks	It's better with 2 professionals. If a child is not interested or not attentive, then toys or paddles can be used. In case of a poor result: attention problems must be taken into account.
Test duration	5 min.

Table 4.32: Toys and Stycar balls Tests

Visual Field	
Specific function	Kinetic perimetry
Name of the test / subtest	Goldmann
Age (years)	6−12
Standardisation	
Description of the task	A Goldmann perimeter [7] utilizes different-type targets that can be varied according to size and light intensity. The larger or brighter objects are perceived in the periphery while smaller targets outline boundaries and defects of the central visual field [25]
Clinical remarks	Targets recommended are V4, V1, III1 and II1 in low vision. Monocular testing.
Test duration	20 min.

Table 4.33: Goldmann Test

4.3 Neurovision

Introduction

The evaluation of neurovision is a part of the multidisciplinary Protocol of Assessment. It is important to use the information gathered from the low vision assessment in order to be able to analyse and interpret the results of the testing of high visual functioning. In order to obtain a consensus of assessments to be recommended as part of the neurovision evaluation, the following steps were followed:

1. As a first step, all partners presented relevant information about assessments used with the clients studied in this project.

2. This information was then structured to follow the hierarchy recommended by Zuidhoek (2015) and Zuidhoek & Hyvarinen (2015) in "Vision and the Brain" [48]. First, the emotions, motivations and needs of the child, plus the characteristics of its surroundings, determine the use of attention management and other executive functions that control the functions of attention. Without sufficient attention to the visual sense, adequate perception will not come about.

3. With collaboration from all the partners, each possible assessment tool was analysed in regards to its relevance with the target clientele for the 3 to 6 and the 6 to 12 years old category. Items deemed not relevant for the population were removed with a proper justification, whereas items deemed relevant were selected to be included in the handbook.

4. We selected the tests which are standardised. If no standardised tools were available we selected others based on clinical observations. Where possible we have added clinical remarks for the use of these tests with this specific populations of clients.

5. 5. Another model seems interesting to name although it was originally developed for visual agnosias of the cerebral adult, the Humphreys and Riddoch (1987) model (see appendix III). This model takes into account the distinction between the perceptual treatments and the representative (or mnesic) treatments of the object. This distinction served as the neuropsychological basis for Riddoch and Humphreys (1993) to create the Birmingham Object Recognition Battery (BORB). This battery arose from a clinical interest to use the detailed assess-

ment procedure for exploring visual agnosias in children with neurological diseases (McCabe et al. (2016), Gillet P. et al, (2009)).

The neurovision section of the protocol is part of an interdisciplinary approach, including exchange and collaboration between the disciplines who work with the child. Observations reported by the parents, family, caregivers about the child's visually guided behaviour can be collected using the questionnaire (third output). Moreover, this part can be inscribed within a more complete neuropsychological evaluation (Table 1) which will not be repeated here in great detail.

Little research has been done to validate neuropsychological test accommodation and modification practices that deviate from standard test administration or to develop test parameters and interpretive guidelines specifically for persons with different physical or sensory disabilities. When using traditional tests with individuals with visual impairment, the neuropsychologist will pay particular attention by selecting tests and modifications that harm, the least possible, to the performance of people based on an awareness of level of disability and knowledge of accommodations for impairment in vision. The clinician must be aware, however, that due to an unstandardised test administration or response format, validity of normative data and interpretation guidelines is broken. A precise interpretation of the results will require the understanding by the neuropsychologist of the complex influence of demographic, etiological and disability factors on neuropsychological performance (Hill-Briggs F. et al., 2007). For this purpose, we propose to follow a procedure for the evaluation of the superior visual functions and the tests which appear to us, in our clinical practice, to be visually better suited for children with CVI and/or low vision acuity (0.05 to 0.5 or 6/120 to 6/12). The criteria to select the tests are set by the relevance of the tests to the project: children from 3-12 years old; visual acuity $0.05 - 0.5$ with suspicion of CVI; Verbal cognitive level ¿ 70; The standardization of the test; The international authenticity of the test.

General assessment

The neurovision evaluation should be considered as part of a general neuropsychology assessment. In fact, all requirements for visual analysis need to be assessed beforehand in order to obtain a differential diagnosis. However, assessments used in a general neuropsychology evaluation will not be discussed in this research as the focus will be on assessments specifically used in the context of CVI. The table 4.34 contains cognitive functions usually considered in a general neuropsychology evaluation and the assess-

ment tools used to evaluate them according to a visual and an auditory modality.

Emotional state - Intellectual abilities - Instrumental functions - Executive functions - Attention - Memory

Emotional state	Personality, availability, participation, mood, anxiety
	Fear of failure, competence, behavioral problems
Intellectual abilities	Verbal Comprehension Index (VCI)
	Visual Spatial Index (VSI)
	Fluid Reasoning Index (FRI)
	Working Memory Index (WMI)
	Processing Speed Index (PSI)
Instrumental functions	Language (expression/understanding)
	Praxia
	Gnosia
Executive functions	Inhibition
	Flexibility
	Planification/Organization
Attention	Auditive and visual Attention
	Sustained attention, divided attention, selective attention, controlling endogenous attention, controlling exogenous attention
Memory	Auditive and visual memory(encoding, storage, recovering)
	Episodic, semantic, procedural memory

Table 4.34: Global Assessment

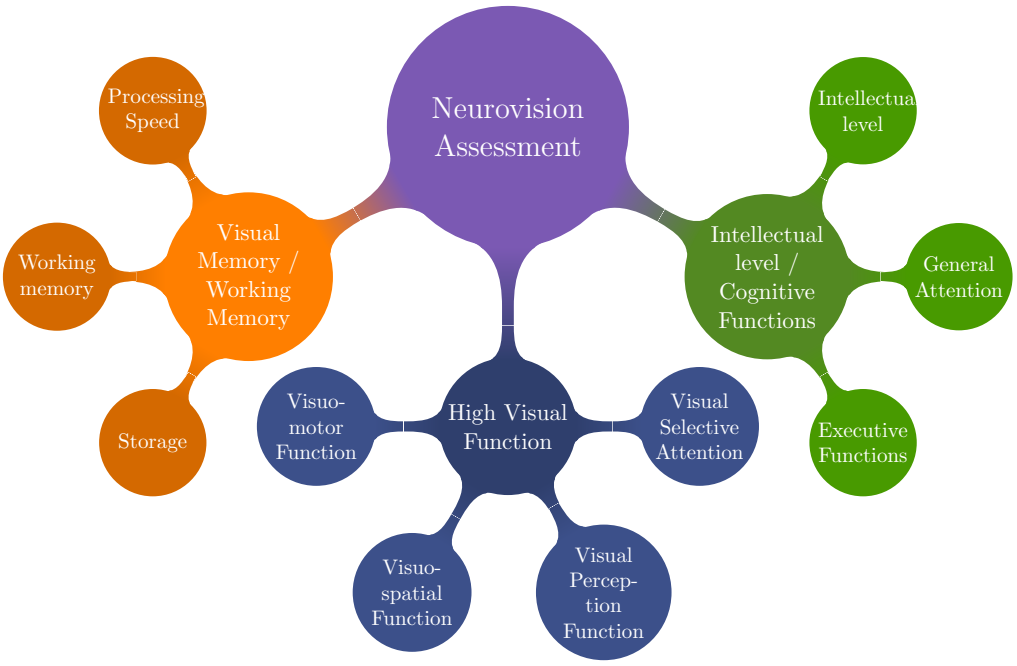


Figure 4.2: Neurovision mindmap

Ideally, the key to choose a valid task is to be sure that it will evaluate or implicate only one function in the task asked. However, any task used requires many brain functions. So as recommended by Zuidhoek, Hyvrinen, Jacob and Henriksen (Vision and the Brain, 2015, Chap. 13), it is important to make sure that the demand on the executive and attention functions is as low as possible by:

- Using simple, short instructions.
- Avoiding having the child choose from multiple pictures if possible.
- Not presenting more than one test item on one page.
- Acknowledging that picture-naming tasks depend on active vocabulary.
- Reducing the fine motor activity involved in the task.

It is possible to add to this protocol a section that gives a general idea or a screening of the child's visual abilities. Indeed, some tests are not built to specifically evaluate a visual function but are still useful for forming future evaluation hypotheses (eg. TVPS, Beery's, VMI, MVPT-3, DTVP-2,

Frostig, image-drawing, etc.). In this part of the protocol, we have maintained the set of functions that we consider important to document in children with CVI and low vision. However, to our knowledge, for some of these functions there are no standardised evaluations that test this function specifically. We will still name these functions, even though there are no tests available, so the clinician can remember that this is also an important aspect to document for the CVI child, for example from observations.

In addition, some tests presented in this protocol are not always "pure" tests that only involve the identified function. Thus, it is often a task that involves other functions in the performance of the activity. However, we have chosen to present the most commonly used tests in our clinical practices. We wanted to offer a choice, although imperfect, to the clinician who must document the neurovisual aspect of the child with a diagnosis of CVI and low vision.

This work is inspired by the exchange between our respective clinical practices in each of our countries. It is by no means argued that these are the only possible choices. Indeed, there are probably a large number of tools that we do not know or do not currently use and that could be quite relevant in assessing the youth with CVI. The literature also reports various tools that seem interesting but that are sometimes not accessible to the clinicians. We have gathered several tests for each function. They are not meant to use them all but to choose at least one per each function.

Selected tools

In this section (the "Neurovision protocol"), we separated the subtests of a battery into different parts to measure each function. The tools proposed in this project require special knowledge and skills and should only be used by qualified professionals. The purpose of this paper is a recommendation only. This description does not replace appropriate training for the administration of the test. When choosing the appropriate test for the assessment, we recommend to use the most recent version of each test.

For the CVI evaluation we need to have a general reference of the abilities of the child. So we recommend to start the assessment procedure gathering some general information of the functioning of the child, especially the verbal IQ, general attention and executive functioning.

For the neurovision assessment we decided to describe the high visual function and high visual function that require memory and working memory.

Thus, the structure finally retained is the following:

1. Instruments to assess intellectual level [19, 41, 42, 43] and cognitive functions necessary to allow visual processing functions
    a) Instruments to assess intellectual level
    b) Instruments to assess general attention (maintaining, dividing and selective attention)
    c) Instruments to assess executive functions (flexibility/switching, planning, update, inhibition)
2. Instruments to assess high visual function
    a) Visual selective attention (Global vs local visual selective attention)
    b) Visual perceptual functions (visual identification)
    c) Visuospatial functions (location perception vs orientation perception [36]))
    d) Visuomotor functions (presented in the daily life section)
3. Instruments to assess high visual function that require memory and working memory
    a) Visual memory functions (storage)
    b) Visual working memory functions
    c) Visual processing speed

Instruments to assess intellectual level and cognitive functions necessary to allow visual processing functions

Instruments to assess intellectual level

Intellectual level	
Specific function	Verbal IQ
Name of the test / subtest	WPPSI−III, WPPSI−IV
Age (years)	2−7
Standardization	WPPSI norms exist for many countries
Description of the task	The Wechsler Preschool and Primary Scale of Intelligence (WPPSI), is an individually administered intelligence test for children between the ages of 2 and 7 year
Clinical remarks	The most popular test, used internationally to assess the intellectual potential of children with CVI and low vision
Test duration	90−120 min

Table 4.35: WPPSI Test

Intellectual level	
Specific function	Verbal IQ
Name of the test / subtest	WISC−III, WISC−IV, WISC−V (2014)
Age (years)	6−16
Standardization	WISC norms exist for many countries
Description of the task	The Wechsler Intelligence Scale for Children (WISC), is an individually administered intelligence test for children between the ages of 6 and 16
Clinical remarks	The most popular test, used internationally to assess the intellectual potential of children with CVI and low vision
Test duration	90−120 min

Table 4.36: WISC Test

Instruments to assess general attention

General Attention	
Specific function	Maintaining attention
Name of the test / subtest	Continuous Performance Test [4] (K−CPT−2; CPT−II; CPT−3)
Age (years)	4−7 (K-CPT−2), 6−adult (CPT−II), 8−adult (CPT−3)
Standardization	Yes, US Canada
Description of the task	Clients presented with repetitive boring task, during 14-minutes children are required to push the spacebar when any letter, except "X", appears. The child must maintain their focus over all the period of time in order to respond to targets or inhibit response to non-targets. The version CPT−II and CPT−3 are with letters and the version K−CPT−II are pictures. Computational Visual task, internationally used. Performance/Task based assessment that measures different areas of attention such as sustained attention, inattentiveness, impulsiveness, and vigilance
Clinical remarks	It's white on black stimulus
Test duration	14 min.

Table 4.37: Maintaining attention (CPT) Test

[2]

[2]Selective attention: See section "Visual Selective Attention" below

General Attention	
Specific function	Maintaining attention
Name of the test / subtest	Bourdon−Vos
Age (years)	6−17
Standardization	Yes, Netherlands
Description of the task	It's a pen−and−paper cancellation test where the child is asked to mark all groups of four dots, which are surrounded by groups of three and five dots
Clinical remarks	The Dot cancellation test or Bourdon−Wiersma test is a commonly used test of combined visual perception and vigilance. targets are small, not suitable for low vision (<0.10). The document can be enlarged (from A4 to A3 format or at 125%), which may affect the standardization of the test but remains interesting for clinical observation[40]
Test duration	Variable, around 10−20 min.

Table 4.38: Maintaining attention (Bourdon−Vos) Test

General Attention	
Specific function	Dividing attention (Between modalities)
Name of the test / subtest	Sky Search Dual Task [26] (TEA-Ch) selective/focused attention
Age (years)	6−15 (UK), 6−12 (France), 6−12 (NL)
Standardization	Yes, French, English, Dutch, UK, Australia
Description of the task	This is a brief, timed subtest. In this dual task the children are asked to combine two tasks of finding spaceships (Sky Search) on a sheet filled with very similar distractor spaceships and keeping a count of scoring sounds (Score!)
Clinical remarks	The target used have a good size to be discriminate and the contrast is sufficient
Test duration	5 min.

Table 4.39: Dividing attention Test

Instruments to assess executive functions

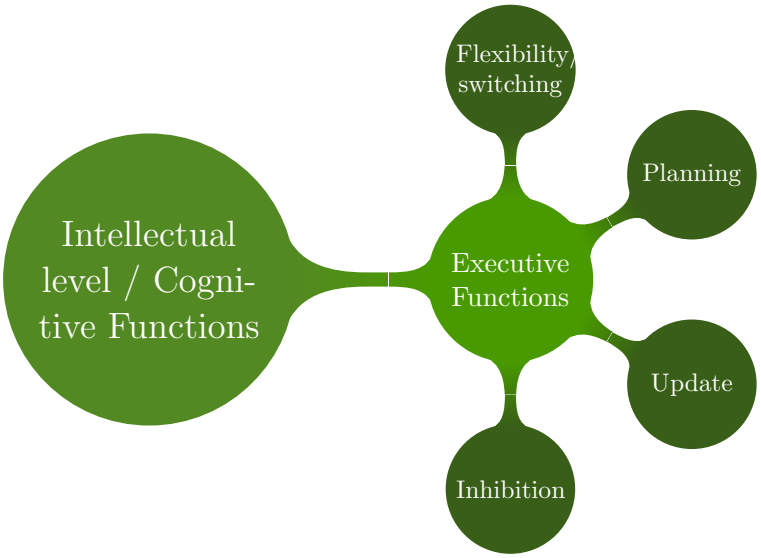


Figure 4.3: Instruments to assess executive functions

Specific Function	Name of the test / subtest
Flexibility/ switching	Creature counting [26] (TEA-Ch) attentional control/ switching
	Trail Making test (Part B)
	Wisconsin [22] (FEE), WCST, WCST-64 (short form)
	Inhibition (NEPSY-II) [2], (Part flexibility)
Planning	Mazes [41] (Wisc-III; Laby 5-12 [27])
	Tower of London, Tower (NEPSY, D-Kefs) [46]
Update	Animal Sorting (NEPSY-II) [2]
Inhibition	Opposite worlds [26] (TEA-Ch)
	Inhibition (NEPSY-II) (Part Inhibition)
	Day-night [12]

Table 4.40: Instruments to assess executive functions

Executive Functions	
Specific function	Flexibility/ Switching
Name of the test / subtest	Creature counting (TEA-Ch) attentional control / switching
Age (years)	6-15 (France), 6-12 (NL)
Standardization	Yes, French, English, Dutch (UK)
Description of the task	Children have to repeatedly switch between two relatively simple activities of counting upwards and counting downwards. They are asked to count aliens in their burrow, with occasional arrows telling them to change the direction in which they are counting. Time taken and accuracy are scored in this subtest.
Clinical remarks	Material is suitable for our population. Contrast and size are good for children with low vision
Test duration	5 min

Table 4.41: Creature counting

Executive Functions	
Specific function	Flexibility/ Switching
Name of the test / subtest	Trail Making test (PartB)
Age (years)	Intermediate version 7-13 [3]
Standardization	Yes English (US) French not available yet (in progress)
Description of the task	Trail Making test for children (test of visual attention and task switching). It consists of two parts in which the subject is instructed to connect a set of 25 dots as quickly as possible while still maintaining accuracy.
Clinical remarks	Interesting to get a clinical observation on how the child is organised. The test can provide information about visual search speed, scanning, speed of processing, mental flexibility, as well as executive functioning. Child needs to know numbers and letters
Test duration	5-10 min

Table 4.42: Trail Marking

[3] Anderson et al. (1997)

Executive Functions	
Specific function	Flexibility/ Switching
Name of the test / subtest	Wisconsin (FEE) WCST WCST-64 (short form)
Age (years)	6.5-89, 8-89
Standardization	yes US (Heaton et al. (1993)). Norms in France are in process.
Description of the task	The test consists of four stimulus cards, placed in front of the subject (one red triangle, two green stars, three yellow cross and four blue circles). The subject is then given a pack of responses cards which have designs similar to those on the stimulus cards varying in colour, geometric form, and number. The subject is told to match each of the cards in the decks to one of the four key cards and is given feedback each time whether he/she is right or wrong.
Clinical remarks	This test is interesting on a qualitative way.
Test duration	15-30 min

Table 4.43: Wisconsin (short form)

Executive Functions	
Specific function	Flexibility/ Switching
Name of the test / subtest	Inhibition (NEPSY-II) (Part flexibility)
Age (years)	5-16
Standardization	Yes: Spanish, French, English, US, Dutch
Description of the task	The child looks at a series of black and white shapes or arrows and names either the shape or direction or an alternative response, depending on the colour (black or white) of the shape or arrow. Inhibition utilizes the Stroop approach with a non reading naming task. This timed subtest is designed to assess the ability to inhibit automatic responses in favor of novel responses and the ability to switch between response types.
Clinical remarks	
Test duration	5-10 min

Table 4.44: Inhibition

Executive Functions	
Specific function	Planning
Name of the test / subtest	Mazes (Wisc-III; Laby 5-12)
Age (years)	6-16 and 5-12
Standardization	Yes: US, French, English
Description of the task	Children must complete a maze with increased difficulty.
Clinical remarks	Navigating a maze supposes oculo-motor skills, visuo-spatial skills, strategy, executive functions (planning, inhibition (impulsivity) and change problem-solving approaches), fine motor skills. Preferably, we recommend the use of WISC-III Mazes.
Test duration	10-20 min 5-10 min

Table 4.45: Mazes

Executive Functions	
Specific function	Planning
Name of the test / subtest	Tower of London, Tower (NEPSY)
Age (years)	7-89
Standardization	Yes: English
Description of the task	The measure consist of 10 problems of ascending difficulty. The examinee is required to move coloured beads mounted on three vertical pegs to match a presented configuration in accordance with two strictly enforced problem-solving rules.
Clinical remarks	The tower of London can provide valuable information concerning an individual's executive planning abilities (Problem solving and Planning)
Test duration	10-15 min

Table 4.46: Tower of London

Executive Functions	
Specific function	Update
Name of the test / subtest	Animal Sorting (NEPSY-II)
Age (years)	5-16
Standardization	Yes: Spain, French, English, US, Dutch
Description of the task	The child sorts cards into two groups of four cards each using various self-initiated sorting criteria.
Clinical remarks	This subtest is designed to assess the ability to formulate basic concepts, to transfer those concepts into action (sort into categories), and to shift set from one concept to another. Material not suitable for children with low vision because picture are too small and complex with many details. No other tests known today
Test duration	5-10 min

Table 4.47: Animal Sorting

Executive Functions	
Specific function	Inhibition
Name of the test / subtest	Opposite Worlds (TEA-Ch)
Age (years)	6-15 (U.K), 6-12 (France), 6-12 (NL)
Standardization	Yes: French, English Dutch (UK)
Description of the task	In the Same World, children follow a path naming the digits 1 and 2 that are scattered along it. In the Opposite World, the same type of task is presented except the child must now say "one" when they see a 2 and "two" when they see a 1. The speed with which the child can perform the cognitive reversal is the crucial measure.
Clinical remarks	The material offers a good contrast, the figures shown are large enough and are in white on black background.
Test duration	5 min

Table 4.48: Opposite Worlds

Executive Functions	
Specific function	Inhibition
Name of the test / subtest	Inhibition (NEPSY-II) (Part Inhibition)
Age (years)	5-16
Standardization	Yes: Spain, French, English, US, Dutch
Description of the task	The child looks at a series of black and white shapes or arrows and names the alternative response of the shape or the direction of the arrow. Inhibition utilizes the Stroop approach with a non reading naming task. This timed subtest is designed to assess the ability to inhibit automatic responses in favor of novel responses.
Clinical remarks	
Test duration	5-10 min

Table 4.49: Inhibition (NEPSY-II)

Executive Functions	
Specific function	Inhibition
Name of the test / subtest	Day-night
Age (years)	3-7
Standardization	Slightly norms English
Description of the task	In a first condition, children were asked to say the word "day" when shown a picture of the sun and say "night" when shown a picture of the moon. After that, in the interference condition, children were instructed to say the word "day" when shown a picture of the moon and to say the word "night" when shown a picture of the sun. The "day−night" task is a widely used measurement of interference control in young children.
Clinical remarks	
Test duration	5 min

Table 4.50: Day-night

Instruments to assess High visual function

Visual selective attention	
Specific Function	**Name of the test / subtest**
Global selective attention,(Gestalt perception [3])	Kaufman Gestalt Perception
	Visual closure [29, 28] (TVPS - non motor)
	Visual closure (DTVP-2, MVPT-3, DTVP-3)
	Navon letter [30]
Local visual selective attention,(crowding effect)	Sky Search (TEA-Ch) [26]
	Map Mission (TEA-Ch) [26]
	Cancellation,(WISC-V)
	Bourdon (-Vos)
Local visual selective attention,(Embedded figures)	Visual Figure-ground [28] (TVPS, MVPT-3)
	Figure-Ground (DTVP-2/ DTVP-3)
	RAKIT-2 Hidden Figures
	Overlapping figures test [36] (Test 6),(BORB)

Table 4.51: Instruments to assess high visual function (Visual selective attention)

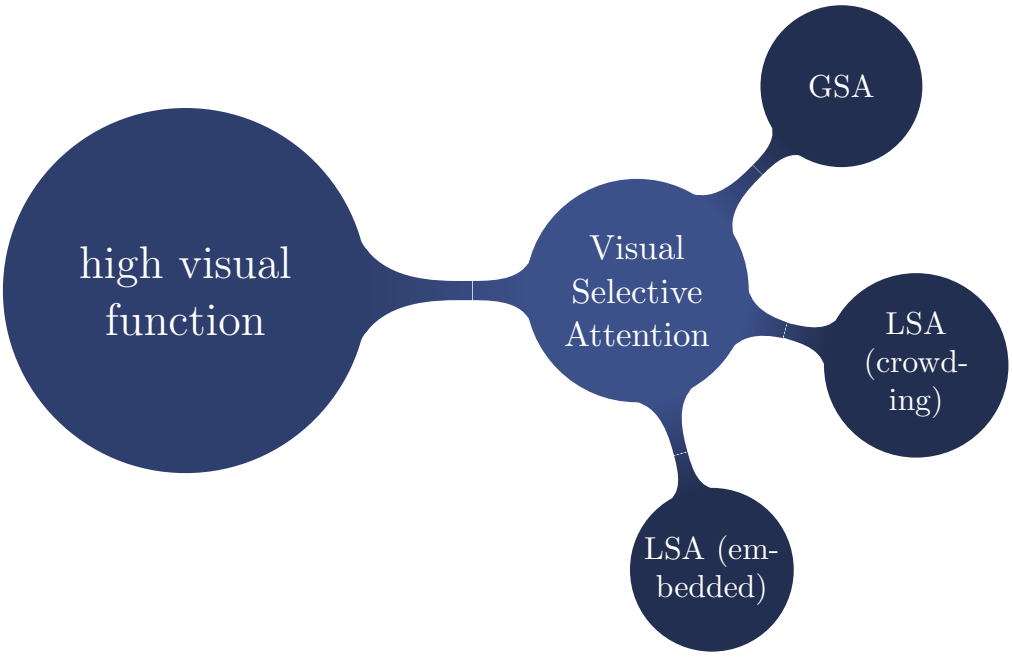


Figure 4.4: Instruments to assess high visual function, visual selective attention. GSA: Global Selective Attention; LSA: Local Selective Attention.

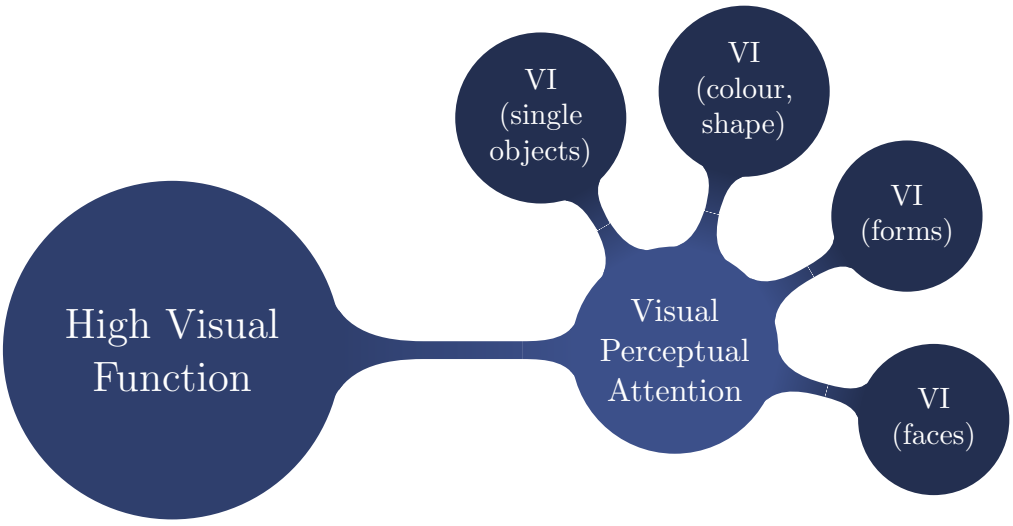


Figure 4.5: Instruments to assess , visual perceptual attention (VI means Visual Identification)

Visual perceptual functions	
Specific Function	**Name of the test / subtest**
Visual identification natural pictures of single objects	Receptive vocabulary [44] picture Naming [36, 44] (WPPSI-IV)
	BORB: Picture naming (test 13 and 14)
Visual,identification colour, shape, etc.	Speed Naming (NEPSY-II) [2]
Visual identification Forms	Form Constancy (DTVP-2)
	BORB: size match task (test 3), orientation match task (test 4), position of gap match task (test 5), overlapping figures (test 6)
Visual identification identification of face	photos (of familiar people for the child)

Table 4.52: Instruments to assess high visual function (Visual perceptual functions)

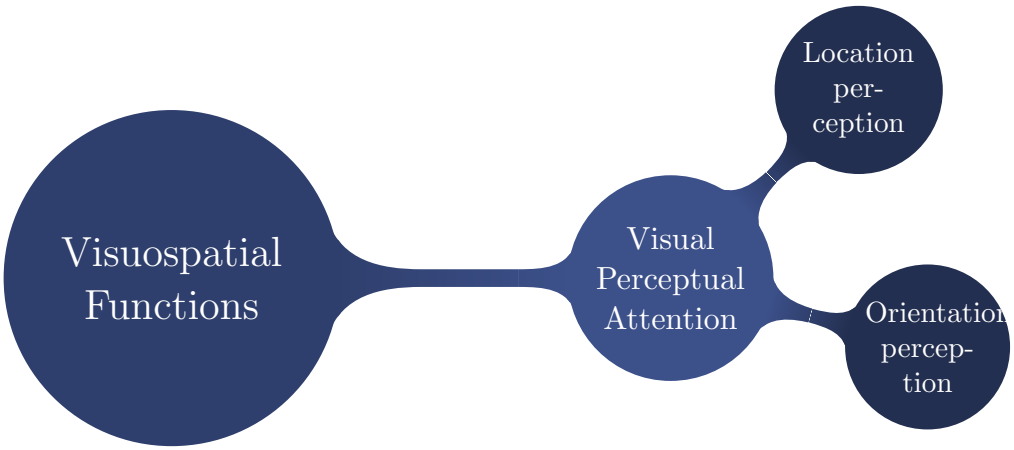


Figure 4.6: Instruments to assess visuospatial functions

Visuospatial functions	
Specific Function	**Name of the test / subtest**
Location perception Designation task	HLT 2.0
	PVSE Test de la perception visuospatiale et élémentaire [34]
Orientation perception [1]	Judgment of line orientation (BENTON)
	Comparison of 2 oriented lines (Same yes/no?) (own material Visio)
	BORB : Orientation match task, position of gap match task 4 and 5 [36]

Table 4.53: Instruments to assess (Visuospatial functions)

Visuomotor functions	
Specific Function	**Name of the test / subtest**
See daily life section	

Table 4.54: Instruments to assess (Visuomotor functions)

Visual selective attention	
Specific function	Global selective attention (Gestalt perception)
Name of the test / subtest	Kaufman Gestalt Perception (real picture)
Age (years)	3-18
Standardization	Yes: UK, German
Description of the task	The child is asked to name/identify fragmented silhouettes of objects of daily life
Clinical remarks	
Test duration	5-10 min

Table 4.55: Global selective attention

Visual selective attention	
Specific function	Global selective attention (Gestalt perception)
Name of the test / subtest	Visual closure [14] (DTVP -2, DTVP-3) Developmental Test of Visual Perception (abstract picture)
Age (years)	4-11, 4-12
Standardization	Yes: UK
Description of the task	The child is shown a stimulus figure and asked to select the exact figure from a series of figures that have been incompletely drawn.
Clinical remarks	Clinical observation suggests that failing this test is most times not the result of impaired gestalt perception but is also affected by inaccurate viewing /scanning or inattentiveness. May also be prone to crowding.
Test duration	5-10 min

Table 4.56: Developmental Test of Visual Perception

Visual selective attention	
Specific function	Global selective attention (Gestalt perception)
Name of the test / subtest	"Visual closure" in TVPS - non motor
Age (years)	4-18
Standardization	Yes: USA, English
Description of the task	The child is asked to point to one of a series of incomplete geometrical shapes that matches the complete shape. Individuals are shown a stimulus figure and asked to select the exact figure from a series of figures that have been incompletely drawn.
Clinical remarks	Advantage of the TVPS on DTVP, is that the items are not surrounded by a frame which might reduce crowding effects
Test duration	5 min

Table 4.57: Visual closure

Visual selective attention	
Specific function	Global selective attention (Gestalt perception)
Name of the test / subtest	Navon letter [30]
Age (years)	Not specified
Standardization	No norms
Description of the task	Large letter (or shape) that is composed of other smaller letters (or shapes). The child is asked to name what is sees, which indicates if he/she attends to the whole or the details, or can name both of them.
Clinical remarks	Very interesting for qualitative information but there's no normative data.
Test duration	About 1-2 min.

Table 4.58: Navon letter

Visual selective attention	
Specific function	Local visual selective attention (crowding effect)
Name of the test / subtest	Sky Search (TEA-Ch) selective/focused attention
Age (years)	6-15 (U.K)
Standardization	Yes: United Kingdom, France, Dutch
Description of the task	This is a brief, timed subtest. Children have to find as many "target" spaceships as possible on a sheet filled with very similar distractor spaceships. In the second part of the task there are no distractors. Subtracting part 2 from part 1 gives a measure of a child's ability to make this selection that is relatively free from the influence of motor slowness.
Clinical remarks	Recommended for children with visual acuity below 0.1.
Test duration	Around 5 minutes

Table 4.59: Sky Search

Visual selective attention	
Specific function	Local visual selective attention (crowding effect)
Name of the test / subtest	Map Mission (TEA-Ch) selective/ focused attention
Age (years)	6-15 (U.K), 6-12 (France), 6-12 (NL)
Standardization	Yes, French, English, Dutch, (UK)
Description of the task	Children have to search a map to find as many target symbols as they can in one minute.
Clinical remarks	Possible for up to 0.1 and recommended for children with good acuity.
Test duration	Less than 5 minutes

Table 4.60: Map Mission

Visual selective attention	
Specific function	Local visual selective attention (crowding effect)
Name of the test / subtest	Cancellation [43] (WISC-V)
Age (years)	6-16
Standardization	Norms exist for many countries
Description of the task	Children scan random and structured arrangements of pictures and marks specific target pictures within a limited amount of time
Clinical remarks	Good with quiet accessible items, but the measure are not relevant in link with the motor and the visual processing speed.
Test duration	Less than 5 minutes

Table 4.61: Cancellation

Visual selective attention	
Specific function	Local visual selective attention (crowding effect)
Name of the test / subtest	Bourdon (-Vos)
Age (years)	6-17
Standardization	Yes: Dutch
Description of the task	The test has been used in the evaluation of stroke where subjects were instructed to cross out all groups of 4 dots on an A4 paper. The numbers of uncrossed groups of 4 dots, groups of dots other than 4 crossed, and the time spent (maximum, 15 minutes) were taken into account.
Clinical remarks	Only usable with visual acuity over 0.10; qualitative observations are worthful: missing dots, looking strategy, motivation during the test, signs of fatigue.
Test duration	10-20 mins

Table 4.62: Bourdon

Visual selective attention	
Specific function	Local visual selective attention (Embedded figures)
Name of the test / subtest	"Visual Figure-ground" [15] (Test of Visual-Perceptual Skills (TVPS - non motor)) by Nancy A. Martin
Age (years)	4- 18
Standardization	Yes: English
Description of the task	Child is asked to identify each of a set of overlapping geometrical shapes.
Clinical remarks	Very interesting for children with CVI, to observe their visual treatment in a crowded context
Test duration	5 min

Table 4.63: Visual Figure-ground

Visual selective attention	
Specific function	Local visual selective attention (Embedded figures)
Name of the test / subtest	Figure-Ground (DTVP-2/ DTVP-3)
Age (years)	4-11, 4-12
Standardization	Yes: English
Description of the task	Child is asked to identify each of a set of overlapping geometrical shapes.
Clinical remarks	Very interesting for children with CVI, to observe their visual treatment in a crowded context. Advantage of the DTVP on the TVPS, is that the items are less complex and more simple for children with low vision
Test duration	5 mins

Table 4.64: Figure-Ground (DTVP-2/ DTVP-3)

Visual selective attention	
Specific function	Local visual selective attention (Embedded figures)
Name of the test / subtest	RAKIT-2 Hidden Figures
Age (years)	4-12
Standardization	Yes: Dutch
Description of the task	Figures are hidden in a complex, confusing background of lines. The child is asked to choose which of six options is fully recognizable in the line-structures.
Clinical remarks	This test is, unfortunately, only in Dutch, but however, it is a test interesting to know.
Test duration	10 min

Table 4.65: RAKIT-2 Hidden Figures

Visual selective attention	
Specific function	Local visual selective attention (Embedded figures)
Name of the test / subtest	Overlapping figures test (test 6) (Birmingham Object Recognition Battery (BORB)
Age (years)	This battery was normed for adults but it exists for children.
Standardization	English (UK), small population
Description of the task	Composed of two parts: first, the subject is invited to name images presented one by one. In a second step, the subject must denominate the same images, but presented overlapped in pairs. This battery provides a set of 14 separate standardised subtests for assessing neuropsychological disorders of visual object recognition and visual processing, based on tests developed in the cognitive neuropsychological literature.
Clinical remarks	Very interesting battery because it follows each level of Humphreys et Riddoch model of visual perception.
Test duration	5 to 10 mins

Table 4.66: BORB

Visual perceptual functions

Visual perceptual functions	
Specific function	Visual identification natural pictures of single objects
Name of the test / subtest	Picture Naming (WPPSI-IV)
Age (years)	4-7
Standardization	WPPSI norms exist for many countries
Description of the task	Colourful images are presented to the child, one at a time, and this one must denominate them.
Clinical remarks	The images used have a good size to be discriminate and the contrast is sufficient.
Test duration	5 mins

Table 4.67: Picture naming

Visual perceptual functions	
Specific function	Visual identification natural pictures of single objects
Name of the test / subtest	Picture naming (Birmingham Object Recognition Battery (BORB)(test 13 and 14) : items come from animate categories (eg. animals) and inanimate catgories (clothing, furniture, vehicules, etc.)
Age (years)	This battery was normed for adults but it exists for children
Standardization	English (UK), small population
Description of the task	In this subtest, a picture is presented to the child and he must name it. This battery provides a set of 14 separate standardised subtests for assessing neuropsychological disorders of visual object recognition and visual processing, based on tests developed in the cognitive neuropsychological literature.
Clinical remarks	Very interesting battery because it follows each level of Humphreys et Riddoch model of visual perception.
Test duration	5 to 10 mins

Table 4.68: BORB: Picture naming

Visual perceptual functions	
Specific function	Visual identification color, shape, etc.
Name of the test / subtest	Speed Naming (NEPSY-II)
Age (years)	3-16
Standardization	Yes: English, French, Spanish and Dutch
Description of the task	This timed subtest is designed to assess rapid semantic access to and production of names of colors, shapes, sizes, letters, or numbers. The child shown an array of colors, shapes, and sizes; or letters and numbers. The child names them in order as quickly as possible.
Clinical remarks	We can use this task to have qualitative information on the capacity of the child to identify color, shapes, sizes, letters or numbers. But the norms can't be used because this task is not created for this. The norms can be used to measure visual identification since they are created to measure semantic processing speed.
Test duration	about 5 mins

Table 4.69: Speed Naming

Visual perceptual functions	
Specific function	Visual identification forms
Name of the test / subtest	Form Constancy [15] (DTVP-2)
Age (years)	4-12
Standardization	Yes: UK
Description of the task	The child is asked to point to two shapes that are the same shape as a sample shape, but differ in their visual lay-out (orientation, line with, fill, part of another shape).
Clinical remarks	This task also needs appropriate visual selective attention and can be more difficult for children with problems in that function.
Test duration	about 5 mins

Table 4.70: Form Constancy

Visual perceptual functions	
Specific function	Visual identification forms
Name of the test / subtest	Length match task (test 2), size match task (test 3), orientation match task (test 4), position of gap match task (test 5)
Age (years)	This battery was normed for adults but it exists for children
Standardization	English (UK), small population
Description of the task	Subject is asked to indicate if the 2 items were differences or similar in length (test 3), size (test 4), orientation (test 5) or position of gap (test 6)
Clinical remarks	The use of a cache may be necessary, in order to present only the item to be treated by the child.
Test duration	5 to 10 mins

Table 4.71: BORB: length, size, orientation and position of gap tasks

Visual perceptual functions	
Specific function	Visual identification of face. Visual modality, Photo's: naming of (fake) celebrities
Name of the test / subtest	No specific test existing
Age (years)	
Standardization	Not standardised
Description of the task	Photos of famous or international celebrities among pictures of regular people; the child tells if the person is known or not and asked to name the person (for example the Queen, Michael Jackson).
Clinical remarks	
Test duration	

Table 4.72: Celebrities/regular people

Visual perceptual functions	
Specific function	Overall visual perceptual ability
Name of the test / subtest	MVPT-3 (Motor Free Visual Perception Test)
Age (years)	4-95
Standardization	Yes: English (US)
Description of the task	Perceptual tasks include spatial relationships, visual discrimination, figure-ground, visual closure, and visual memory. Simple black and white line drawings for both the stimulus items and answer choices (multiple-choice format). Primarily matching tasks to assess all types of perceptual ability. Do not require any visuo-motor skills.
Clinical remarks	A relatively short (one) test of the general visual perceptual ability
Test duration	20 min.

Table 4.73: MVPT-3 (Motor Free Visual Perception Test)

Visuospatial functions

Visuospatial functions	
Specific function	Location perception. Designation task (same location)
Name of the test / subtest	PVSE-Subtest 6
Age (years)	4-12
Standardization	Yes: French
Description of the task	Location perception. Two squared frames are positions next to each other with a dot positioned in each of them. The child is asked to identify is the dots are in the same position.
Clinical remarks	the material is accessible but the analysis of the result is not enough detailed.
Test duration	About 5 min.

Table 4.74: PVSE-Subtest 6

[4]Lindgren and Benton, 1980

Visuospatial functions	
Specific function	Orientation perception
Name of the test / subtest	Judgment of line orientation (BENTON)
Age (years)	7-14[4]
Standardization	Yes: UK
Description of the task	A stimulus booklet is presented to the child with two target lines in the upper part of the booklet and the multiple choice response card appearing in the lower part. It is ask to the child to point or name the number of the line in the response-choice display that correspond to the lines (that are in the same orientation) on the upper stimulus page. There is no time limit for responding. The subjects are allow to hold and position the test booklet to their best advantage.
Clinical remarks	A standardised measure of visuospatial judgment in two alternate forms.
Test duration	about 5-10 min

Table 4.75: Judgment of line orientation

Visuospatial functions	
Specific function	Orientation perception. Designation task (same location)
Name of the test / subtest	Orientation match task (test 4), position of gap match task (test 5), Birmingham Object Recognition Battery (BORB)
Age (years)	This battery was normed for adults but it exists for children
Standardization	English (UK), small population
Description of the task	Subject is asked to indicated if the 2 items were different or similar in orientation (Test 4) or position of gap (Test 5).
Clinical remarks	Sometimes it's difficult to analyse with children with low vision.
Test duration	5 to 10 min

Table 4.76: BORB: Comparison of 2 oriented lines

Instruments to assess that require memory and working memory

Visual memory [29] functions (Storage)	
Specific Function	**Name of the test / subtest**
Short term memory	Visual Memory (MEM) (TVPS III)
	Visual Sequential -memory (SEQ) (TVPS III)
	Picture memory WPPSI-IV
	Dot location (storage), Immediate recall (CMS)
Long term memory	Dot location, learning (CMS)
	Drawing (CMS)

Table 4.77: Visual memory functions (Storage)

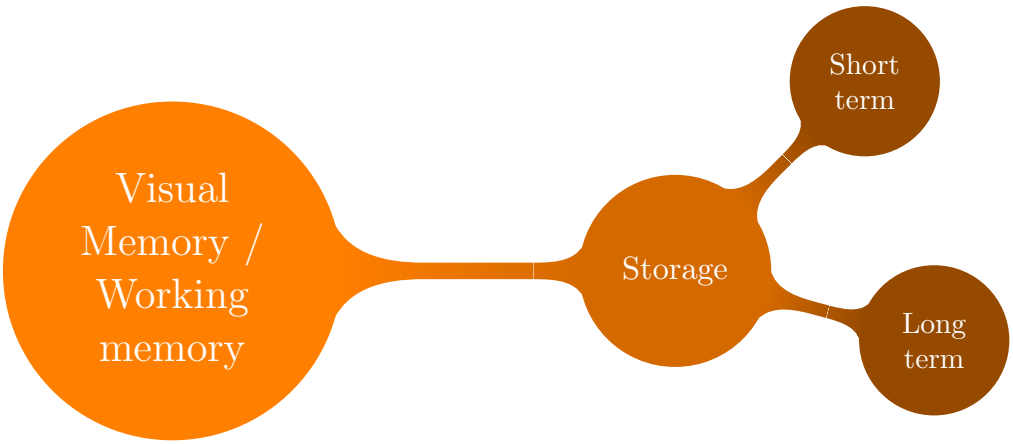


Figure 4.7: Instruments to assess Visual Memory functions (Storage)

Visual working memory functions	
Specific Function	**Name of the test / subtest**
Mental image generation/ visually adding information to incomplete picture	Visual closure (TVPS-III-CLO, DTVP-3, MVPT-3)
	Geometric Puzzles (NEPSY-II) [2]
Mental rotation Mental self-rotation (to lesser extent also object (map) rotation)	Visual puzzle [43] (WISC-V)

Table 4.78: Visual working memory functions

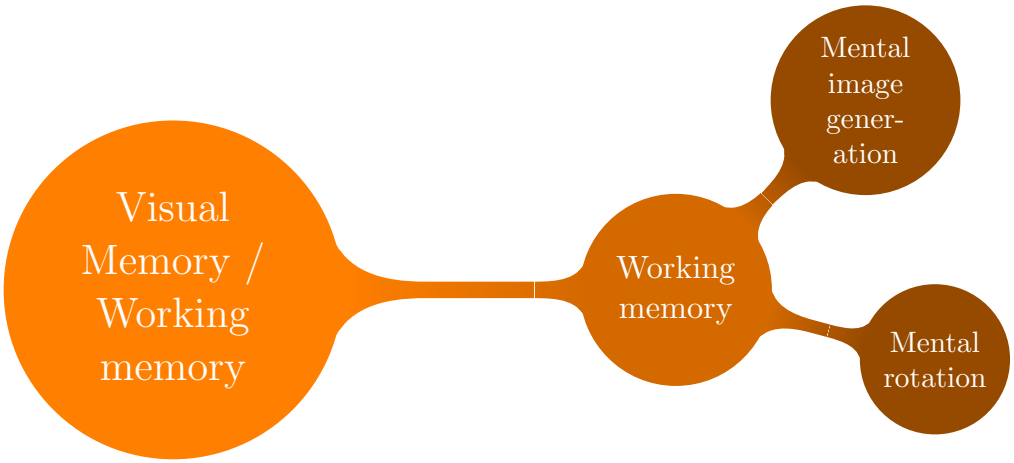


Figure 4.8: Instruments to assess Visual Memory functions (Working memory)

Visual processing speed	
Specific Function	**Name of the test / subtest**
Verbal response	"Real World" in Opposite Worlds (TEA-Ch)

Table 4.79: Visual processing speed

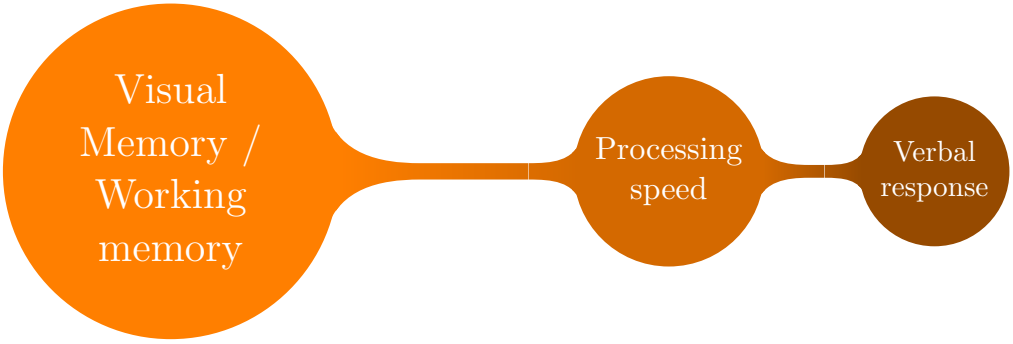


Figure 4.9: Instruments to assess Visual Memory functions (Processing speed)

Visual memory functions (Storage)	
Specific function	Short term memory within one attentional, working memory episode
Name of the test / subtest	Dot location (CMS−storage): immediate recall
Age (years)	5-16
Standardization	Yes: English(USA), French
Description of the task	The child is presented a set of learning trials and asked to recall location of dots. A single presentation and recall of a distractor array, then recall of the first dot array, follows. In the delay portion, the child is asked to recall the dot array presented earlier.
Clinical remarks	Interesting and useful for our target group
Test duration	5 minutes plus delay of 25 minutes

Table 4.80: CMS dot location (storage)

Visual memory functions (Storage)	
Specific function	Semantic memory (over 2 minutes but less than 1 day)
Name of the test / subtest	Dot location (CMS- storage): learning
Age (years)	5-16
Standardization	Yes: English(USA), French
Description of the task	The child is presented a set of learning trials and asked to recall location of dots. A single presentation and recall of a distractor array, then recall of the first dot array, follows. In the delay portion, the child is asked to recall the dot array presented earlier.
Clinical remarks	Interesting and useful for our target group
Test duration	5 minutes plus delay of 25 minutes

Table 4.81: CMS dot location (long term storage)

Visual memory functions (Storage)	
Specific function	Longer term memory (over 2 minutes but less than 1 day)
Name of the test / subtest	Drawing [36] Birmingham Object Recognition Battery (BORB)
Age (years)	This battery was normed for adults but it exists for children
Standardization	English (UK), small population
Description of the task	Test 9 : Drawing from memory. Subject asked to draw the named 6 items (form for adults : triangle, clock, flower, giraffe, kangaroo, tiger).
Clinical remarks	this subtest is not relevant for children with low vision.
Test duration	5 to 10 min

Table 4.82: BORB: Drawing

Visual working memory functions

Visual working memory functions	
Specific function	Mental image generation/ visually adding information to incomplete picture
Name of the test / subtest	Visual closure (TVPS-III-CLO)
Age (years)	4-18
Standardization	Yes: USA English
Description of the task	Four incomplete forms are presented to the child and he is asked to determine the one that would be the same as the completed form. Mental visual closure determined from parts of a form, the whole form.
Clinical remarks	
Test duration	about 5 min

Table 4.83: TVPS-III CLO

Visual working memory functions	
Specific function	Mental rotation Mental self-rotation (to lesser extent also object (map) rotation)
Name of the test / subtest	Geometric Puzzles (NEPSY-II)
Age (years)	5-16
Standardization	Yes: English, French
Description of the task	In Geometric Puzzles, the child is shown a picture of a large grid containing several shapes. For each item, the child matches two shapes outside of the grid to two shapes within the grid.
Clinical remarks	It is designed to assess mental rotation, visuospatial analysis, and attention to detail.
Test duration	about 5-10 min

Table 4.84: Geometric Puzzles (NEPSY-II)

Visual working memory functions	
Specific function	Mental rotation Mental self-rotation (to lesser extent also object (map) rotation)
Name of the test / subtest	Visual puzzle (WISC-V)
Age (years)	6-16
Standardization	Yes: English, French
Description of the task	Children view a puzzle in a stimulus book and choose from among pieces which three could construct the puzzle. It's not visually accessible.
Clinical remarks	In this task, visual working memory is necessary in forming mental image, but it is not necessary (although very helpful) to rotate the puzzle pieces mentally.
Test duration	about 5-10 min

Table 4.85: Visual puzzle

Visual processing speed

Visual processing speed	
Specific function	Verbal response
Name of the test / subtest	"Real World" in Opposite Worlds (TEA-Ch)
Age (years)	6-16
Standardization	Yes: English, French
Description of the task	In the Same World, children follow a path naming the digits 1 and 2 that are scattered along it.
Clinical remarks	The processing speed of information presented visually by a verbal response. The speed with which the child can perform is the crucial measure.
Test duration	Less than 5 min.

Table 4.86: "Real World" in Opposite World

4.4 Daily Life

Introduction

Two functions (visuomotor and praxia) and one ability (visual exploratory strategies) have to be assessed for Daily Life.

ICF-CY's activities were analysed in order to choose the relevant ones for our population. Those that can be assessed with validated tools are in this section. Those that cannot be assessed with validated tools are integrated in the "Erasmus + questionnaire for relatives and carer givers" and the experimenter can verify the results with their own materials.

Assessment tools

All of the tools mentioned in Table 2.60 are standardised (except for the H test which offers qualitative information).

The experimenter has to pick some tasks in order to assess the visuomotor, the praxia functions and the visual exploratory strategies[5]. Car test, Chinese letters, letters and red dots tests can be found in the annexes of the handbook.

[5]Further information about the following tests can be found in following URL's

- `http://www.healthandcare.co.uk/`
- `http://www.pearsonclinical.com`
- `http://www.hva.nl/achieve/patientenzorg/producten-voor-de-praktijk/ergotherapie/writic.html`
- `http://www.geppe.fr`

Visuomotor

Visuomotor	
Specific function	Eye hand coordination: accuracy
Name of the test / subtest	Nine holes peg
Age (years)	4–19
Description of the task	To put pegs in the holes one by one [35]
Clinical remarks	This test is accessible to children with low vision. The same subtest exists in the Mabc 2. Qualitative information (about the visually guided movement and its accuracy) is more interesting than the quantitative results (about manual dexterity).
Test duration	1 min.

Table 4.87: Nine holes Test

Visuomotor	
Specific function	Eye hand coordination: accuracy
Name of the test / subtest	DTVP-3 / Eye hand coordination subtest
Age (years)	4–10
Description of the task	To draw different types of lines in a pathway
Clinical remarks	To optimise the contrast, it is better to use a pen. For children who can not see the line drew with the pen, it is not recommended to use this test.
Test duration	5 min.

Table 4.88: DTVP-3 / Eye hand coordination subtest

Visuomotor	
Specific function	Eye hand coordination: accuracy
Name of the test / subtest	Mabc2/LB3
Age (years)	3; 0−16; 11
Description of the task	To draw different types of lines in a pathway
Clinical remarks	This test measures also the execution speed. The qualitative information is more interesting than the quantitative results. The gap in the pathway can be too narrow for a child with low vision.
Test duration	2 min.

Table 4.89: Mabc2/LB3 Test

Visuomotor	
Specific function	Eye hand coordination: general
Name of the test / subtest	Mabc2/Balls skills
Age (years)	3-6; 9-10; 11-16
Description of the task	3-6: To catch a bag with two hands. 9-10: To catch a ball with two hands. 11-16: To catch a ball with one hand
Clinical remarks	If the child doesn't succeed, we could try with adapted bag/ball (bigger, other colour, etc.)
Test duration	3 min.

Table 4.90: Mabc2/Balls skills Test

Visuomotor	
Specific function	Eye-hand coordination: accuracy
Name of the test / subtest	Mabc2/Placing pegs
Age (years)	7−10
Description of the task	To put pegs in the holes one by one
Clinical remarks	It is better to add a blue circle around the holes to optimise the contrast. It is important to observe qualitative information about the visually guided movement and its accuracy.
Test duration	1 min.

Table 4.91: Placing pegs

Praxia

Praxia	
Specific function	Manual dexterity
Name of the test / subtest	Mabc2/Threading beads
Age (years)	3–6
Description of the task	To string beads with thread
Clinical remarks	It is better to add a blue circle around the holes to optimise the contrast. It is important to observe qualitative information about the visually guided movement and its accuracy.
Test duration	2 min.

Table 4.92: Threading beads Test

Praxia	
Specific function	Manual dexterity
Name of the test / subtest	Mabc2/Posting coins
Age (years)	3–6
Description of the task	To put coins in a money box
Clinical remarks	It is better to add a white circle around the hole to optimise the contrast. It is important to observe qualitative information about the visually guided movement and its accuracy.
Test duration	1 min.

Table 4.93: Posting coins Test

Praxia	
Specific function	Manual dexterity
Name of the test / subtest	Mabc2/Threading lace
Age (years)	7−10
Description of the task	To put on a lace
Clinical remarks	It is better to add a blue circle around the holes to optimise the contrast. It is important to observe qualitative information about the visually guided movement and its accuracy.
Test duration	2 min.

Table 4.94: Threading lace Test

Praxia	
Specific function	Manual dexterity
Name of the test / subtest	Mabc2/Turning pegs
Age (years)	11−16
Description of the task	To turn the pegs that are in the holes
Clinical remarks	Same clinical remarks as the subtest Placing pegs in the Mabc 2. It is important to observe qualitative information about the visually guided movement and its accuracy.
Test duration	1 min.

Table 4.95: Turning pegs Test

Praxia	
Specific function	Manual dexterity
Name of the test / subtest	Koek (2008)
Age (years)	3–6
Description of the task	To draw different types of lines.
Clinical remarks	This test is accessible to children with low vision. If the child cannot see the lines, make them thicker.
Test duration	5 min.

Table 4.96: Koek 2008 Test

Praxia	
Specific function	Manual dexterity
Name of the test / subtest	Miller function and participation Scale from L.J. Miller/ Visual motor
Age (years)	2;6-3;11/4;0-7;11
Description of the task	To trace curved lines on a fish. To trace mazes. To trace letters.
Clinical remarks	It is necessary to complete all items (with praxia and visual exploratory strategies tasks) to obtain a standardised score for the visuomotor subtest.
Test duration	5 min.

Table 4.97: Miller function and participation scale Test

Praxia	
Specific function	Constructional: volumes
Name of the test / subtest	NEPSY II / blocs
Age (years)	5-16
Description of the task	To reproduce a three-dimensional constructions from models
Clinical remarks	If the child cannot see the lines, make them thicker.
Test duration	30 min.

Table 4.98: NEPSY II / blocs Test

Praxia	
Specific function	Constructional: volumes
Name of the test / subtest	WPPSI or WISC-V/blocs
Age (years)	WPPSI (2; 6-7; 7) WISC-V (6; 0−16; 11)
Description of the task	To reproduce a 2-dimensional constructions from 3 dimensional blocs
Clinical remarks	If the child cannot see the lines, make them thicker. Nepsy II / blocs is easier.
Test duration	

Table 4.99: WPPSI or WISC-V/blocs Test

Praxia	
Specific function	Constructional: volumes
Name of the test / subtest	Mabc2/Construct a triangle with clamping nuts and bolts
Age (years)	11-16
Description of the task	To construct a triangle with clamping nuts and bolts.
Clinical remarks	It is better to add a blue circle around the holes to optimise the contrast.
Test duration	10 min.

Table 4.100: Mabc2/Construct a triangle Test

Praxia	
Specific function	Constructional: 2D
Name of the test / subtest	NEPSY / Design copying
Age (years)	3-16
Description of the task	To copy some forms
Clinical remarks	You can hide the other pictures
Test duration	15 min.

Table 4.101: NEPSY / Design copying Test

Praxia	
Specific function	Constructional: 2D
Name of the test / subtest	DTVP-3 / copying
Age (years)	4-10
Description of the task	To copy some forms
Clinical remarks	You can hide the other pictures.
Test duration	15 min.

Table 4.102: DTVP-3 / copying Test

Praxia	
Specific function	Constructional: 2D
Name of the test / subtest	Beery VMI
Age (years)	4-18
Description of the task	To copy some forms
Clinical remarks	You can hide the other pictures.
Test duration	15 min.

Table 4.103: Beery VMI Test

Visual exploratory strategies

Visual exploratory strategies	
Name of the test / subtest	H test
Age (years)	5-10
Description of the task	Organised exploration on A4 support with distractors. The worksheet is divided in 9 spaces to analyse what type of strategy the child is using + time and accuracy.
Clinical remarks	The letter H is small. For children with low vision, print it in A3 to have qualitative information.
Test duration	3 min.

Table 4.104: H Test

Visual exploratory strategies	
Name of the test / subtest	NEPSY I/ Rabbits
Age (years)	6-12
Description of the task	Organised exploration on a A3 support with distractors.
Clinical remarks	This test is used for qualitative information.
Test duration	3 min.

Table 4.105: NEPSY I/ Rabbits Test

Visual exploratory strategies	
Name of the test / subtest	NEPSY I/ Cats
Age (years)	6-12
Description of the task	Disorganised exploration on a A3 support with distractors.
Clinical remarks	This test is used for qualitative information.
Test duration	3 min.

Table 4.106: NEPSY I/ cats Test

Visual exploratory strategies	
Name of the test / subtest	Cars test
Age (years)	4-9
Description of the task	Disorganised exploration on a A2 support with distractors
Clinical remarks	It is helpful to film the child because they can be really quick to point the cars.
Test duration	2 min.

Table 4.107: Cars Test

Visual exploratory strategies	
Name of the test / subtest	Chinese letters
Age (years)	4;0-7;6
Description of the task	Organised exploration on A4 support without distractors
Clinical remarks	This exploration test is for children with agnosia or with motor difficulties.
Test duration	1 min.

Table 4.108: Chinese letters

Visual exploratory strategies	
Name of the test / subtest	Letters
Age (years)	4;0-7;6
Description of the task	Disorganised exploration on A4 support without distractors
Clinical remarks	This exploration test is for children with agnosia or with motor difficulties.
Test duration	1 min.

Table 4.109: Letters

Visual exploratory strategies	
Name of the test / subtest	Red dots
Age (years)	4;0-7;6
Description of the task	Organised exploration on A4 support (with distractors)
Clinical remarks	This exploration test is for children with agnosia or with motor difficulties.
Test duration	1 min.

Table 4.110: Red dots

Individual passport 5

5.1 Introduction

The CVI passport consists of three sections:

- A manual for the practitioner. This describes how the CVI passport can be created, in consultation with parents and others directly involved.
- A form to be completed by parents and/or the young person, in consultation with the practitioner.
- A keycard: an A5-size card that identifies the principal impediments that the child faces in everyday life as a result of cerebral visual impairment (CVI), plus the possibilities available for adjustment or compensation.

5.2 Manual for the practitioner

Starting out

This manual describes how the practitioner can go about preparing the CVI passport, in consultation with the parents (or with the adolescent if CVI has been diagnosed at a later age). The CVI passport has various purposes. First, it is a document that psychoeducation offers in relation to CVI in a general sense. It does so by explaining what good vision is and what difficulties can arise in different functional areas pertaining to perception. Secondly, it helps parents to recognize the characteristics of

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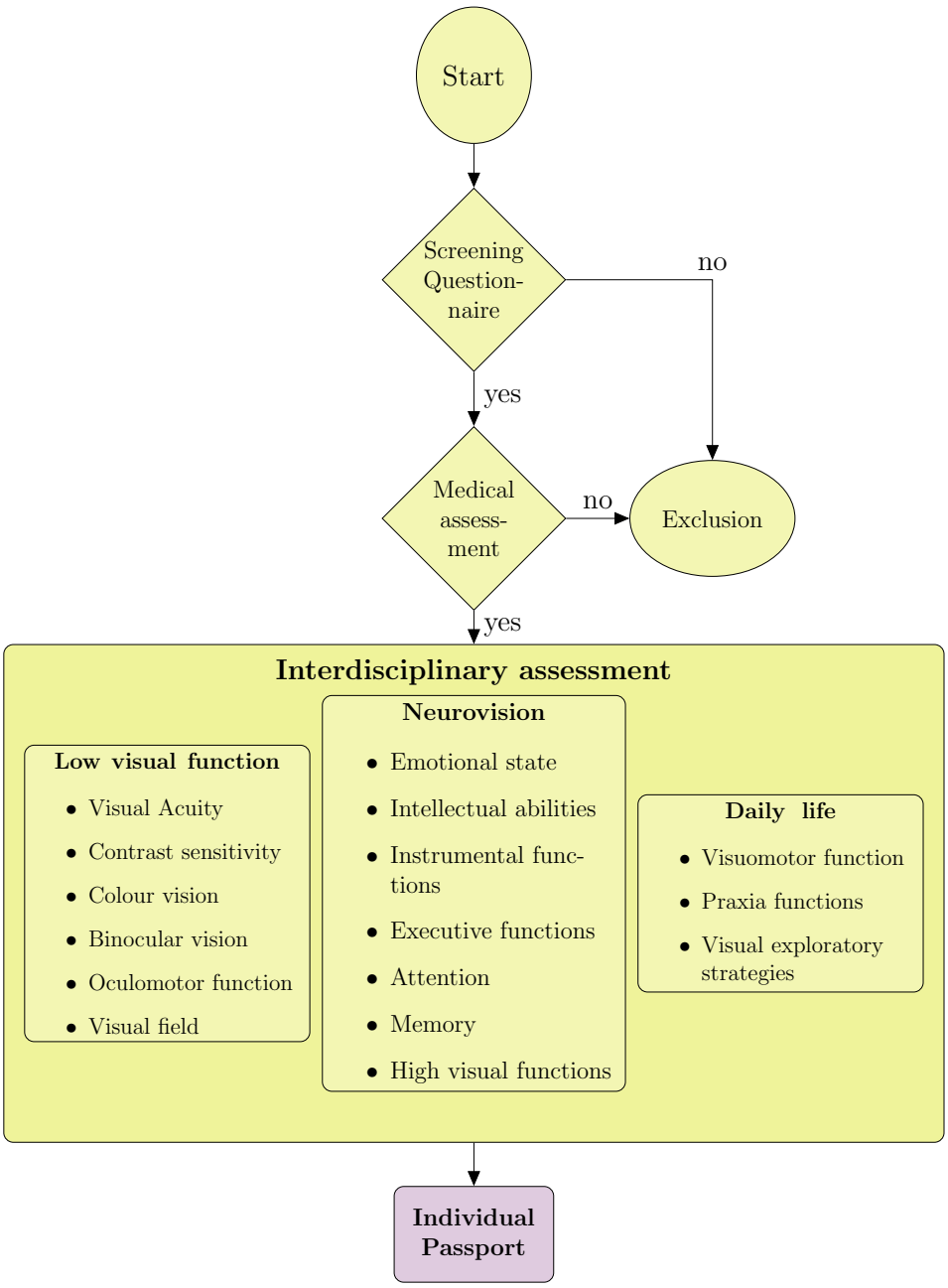


Figure 5.1: General process (Individual Passport)

CVI in their own child. This involves working with concrete examples, preferably provided by the parents or the child him/herself. Thirdly, this document ensures that parents or their child can explain to people in their immediate vicinity what limitations and difficulties they experience as a result of CVI and how these can be compensated in the form of adjustments to the approach or their surroundings or through the use of specific devices.

The CVI passport is first and foremost a working document, of which the child and the parents are the owners. We recommend that the CVI passport is first completed following the diagnostic phase, by the behavioural specialist who has carried out the diagnosis, together with the parents or the adolescent. Parents have just heard that their child has CVI and will often want an explanation. It is decided in each individual case with whom this document can best be completed. We basically recommend that the CVI passport should be completed together with the parents when the child is less than 10 years old, after which the parents provide a brief feedback to their child. Between the age of 10 and 14 it can be completed by the parents together with their child. From the age of 14, it is best that the adolescent completes the document together with the specialist and then he/she informs his/her parents. Regarding the form of feedback and in whose presence, arrangements are made at the end of the process with the parents or their child.

Since CVI has become an umbrella term that encompasses various visual functions that may or may not be affected (or to a greater or lesser extent), this passport provides excellent reference points for psychoeducation. Parents, or the child or adolescent, are unlikely at this point to come up with many personal examples. We therefore recommend sitting down again together with the parents and the child or adolescent at least four months and up to a year later (certainly in a treatment programme that involves compensation or visual training) to discuss the various steps and characteristics. If the treatment is shorter, then this meeting can be planned at the end of the treatment. This makes for a more concrete picture for the parents and provides room, for example, to incorporate growth as a result of a training programme in the document him/herself. Also it is not always evident at the start what compensation skills the child itself is able to deploy or acquire. These can be added at a later point in time. We recommend agreeing with the various disciplines involved who is going to do this. Our advice is that this be done by the field educational supervisor or the practitioner involved (development supervisor or therapist).

While diagnostic practice often looks at visual ability at the functional level, this CVI passport will translate this to the level of activities and participation. It describes various skills and whether the child possesses these

or not, so that the parents get insight into what CVI means in everyday life. The CVI passport starts with a general global definition of visual information processing problems. That is followed by a brief description of the various visual functions. This manual contains concrete examples that can be discussed with the parents. In practically all cases the problems in the processing of visual information problems will not involve all visual functional areas. These will be removed from the CVI passport by the behavioural specialist after the first meeting, so that the ultimate document contains only those functions that are relevant for the child. It will also identify precisely those examples that are most recognisable for parents or within the direct surroundings.

Completing the CVI Passport

The CVI passport starts with a general description of what CVI cerebral visual impairment entails. It is important to explain to parents and others involved that CVI is an ICF-based description and that what is important is the impact that the functional impairments have on the everyday life of the child. Where known, a link can be established with brain damage in a child.

Next, various headings are developed, in line with the assessment protocol. The intention is to discuss these with the parents one by one, to explain what good vision means, and to identify to what extent their child deviates from this. We presume here that it is useful to know what good vision is, because then the visual limitation will be easier to understand. A distinction can then be made between impairment level or the experience of big problems or minor limitations within a specific category. This must ultimately lead to a picture of the consequences of the visual impairments for the everyday life of the child.

Below you will find a description of the various headings from the CVI passport, along with a brief explanation in easily understandable terms that can be discussed with parents. In addition, a list of examples is presented of the difficulties that a child can experience within a specific functional area in everyday life. The list of examples is obviously not exhaustive in any way. It can, however, serve as a starting point for a discussion with parents, with parents and child, or with the adolescent. Where available, exercises are presented that parents can perform, for them to experience what impact the visual impairment can have on a person's ability to perceive things. Following the explanation and the presentation of general examples, a discussion with the parents takes place to see to what extent their child experiences problems in specific situations. The purpose of all this is that

the parents can themselves explain what they consider important within the functional area and that this is included in the passport. In that way you know what the parents have picked up from the information, how they themselves interpret the problem (make sure you link up with this as closely as possible!), and what additional information is required. We assume here that the practitioner decides what must be described in any particular case (since it is relevant for the child) and that the parent decides how it is written down.

As stated earlier, some visual functions will be removed from the passport following the meeting since they are not relevant for the child in question. Some visual functions, however, may be relocated to the compensating factors if the child makes use of these (for example, the use of visual memory for visual closure tasks). Thus the CVI passport strictly contains the key information that best describes the visual functioning of the child in question.

General description of CVI and the visual hierarchy

The general objectives for completion of the CVI passport are discussed with the parents. This discussion includes a general explanation of CVI. It is important to explain that visual perception involves the eyes plus the brain. The brain processes what the eyes offer us. To be able to see well we need good eyes. If the qualitative input from the eyes is low, the processing of that input will be that much more difficult. The following metaphor can illustrate this. Our eyes function like a camera that records the surroundings. The processing of the images produced by the camera is done by means of all types of computer software (the brain).

Conditions for proper perception

During the introduction we also immediately look at the conditions that are necessary for perception. We consider it important to discuss these right from the start, so that parents are aware of the hierarchical functioning within perception. The nature and severity of problems and limitations that a child with CVI experiences depend not only on the nature and severity of the child's impairment(s), but also on the other characteristics and abilities of the child. After all, how well a child sees depends not only on visual functions. Both the low and the high visual functions are dependent on a functional hierarchy, where a child's emotions, needs, motivations and the direct surroundings are at the top. If a child does not want to look properly, or if he/she does not look in a focused way due to distractions in

the surroundings, then he/she will not use him/her visual functions to the full.

The hierarchy is as follows. First, the emotions, motivations and needs of the child, plus the characteristics of its surroundings, determine the use of attention management and other executive functions that control the functions of attention. Without sufficient attention to the visual sense, adequate perception will not come about. Because of the importance of attention, extra explanation is included in this manual. The general conditions for looking are not covered until the end of the CVI passport, among the other relevant factors. After all, within the CVI passport we want to focus first on the visual functions, without ignoring the impact of other problems.

Attention

Before any perception is possible, the ability to see must be looked at. Only with attention to the sensory ability to see will the information that the eyes present to us be processed further and will the visual functions be engaged. In children with CVI, looking is sometimes not primarily a sensory ability to observe the world around them and to adjust their behaviour accordingly. Together with the parents, the viewing behaviour of their son or daughter must also be examined. Is the child's focus on visual perception? Relatively does he/she pay much attention to the other senses? Is the child visually curious? Can he/she focus on visual elements only briefly? Does the child not focus (or not always) on strong visual stimuli? Does the child's looking behaviour vary, in other words is he/she able to look one moment but not the next?

Low visual functions

Visual sensory functions

This relates to the functions of the eye itself, such as the ability to see clearly, to signal information over 180 degrees (peripheral vision), to observe colours and contrasts, and to estimate depth and distance.

- Visual acuity
  Being able to see well is referred to in optical terms as visual acuity of 1.0, also commonly called 100%. Children with poor eyesight have visual acuity of 0.30 or lower. Acuity between 0.3 and 0.5 we call slightly lowered, while between 0.5 and 1.0 is referred to as subnormal. We recommend, for example, explaining to parents that visual acuity of 0.6 corresponds with a child's ability to see details at a viewing

distance of 6 instead of 10 metres. It would mean that the child in question, when looking at a tree, can see the trunk and the foliage, but that the child would have to approach the tree to a distance of roughly 6 metres to be able to see the shape of the leaves, whereas someone with good eyesight would see the same details at a distance of 10 metres. A comparable calculation can be applied for objects nearby (60 centimetres instead of 1 metre, etc.). A child's reduced visual acuity will be noticed by parents when they see him/her reducing the looking distance when watching TV, or when using a tablet or telephone, reading a book, playing with toys, etc.

- Range of vision: description pending.
  - Missing pictures or words (specific side, left, right, middle)
- Ability to recognize colours: description pending.
- Sensitivity to contrasts: description pending.
- Ability to see depth: description pending.

Oculomotor functions

- These functions relate to the ability to focus the eyes in a given direction.
- Fixation: description pending.
- Smooth-pursuit eye movement: description pending.
- Accommodation: description pending.

High visual functions

Visual selective attention

A visual image usually contains too much information to take in at once. We therefore need to select within the visual image (total range of vision). The first selection involves the object on which we want to focus our eyes. The eyes are always directed at a single point. When we focus both our eyes on one point, we see more than that one point. We use our function of visual selective attention to select a part of the visual field, usually an area around the point that our eyes focus on. We determine the size of this area partly on the basis of our personal needs and motivation and partly

on the basis of the intensity of the visual stimuli. For example, when we focus our eyes on the handle of a car, we see either only the handle or the entire car. We usually first select a large area in order to get an overview and the correlation between visual elements. This is called global visual selective attention. After that, we zoom in on a small area in order to view a detail. That we refer to as local visual selective attention. Within the visual field we can also select on the basis of other visual properties, such as a specific form or colour. Some children with CVI always have a large field, as their zoom function is damaged. Others are always zoomed in. Some need considerable time to switch from a large to a small selected visual field or the other way around when it comes to their visual selection attention area. Examples of situations that children may find difficult when their visual selective attention is impaired include:

- Difficulty with the overview in traffic; too much time is required to oversee the situation.
- Focus on visual details rather than on the whole.
- Difficulty with looking for or finding things (due to lack of overview), e.g. toys in a box or clothing in a wardrobe.
- Difficulty with interpreting pictures that are incomplete or lack details.
- Difficulty with overview of visual scenes and/or larger pictures.
- Difficulty with overseeing large or small quantities.
- Difficulty with orientation on a page.
- Prefers to walk along the side or walls of a square or open area.
- Difficulty with finding/looking/observing in visually crowded situations. Such as finding a detail in a cluttered picture or visual surroundings, when confronted with distracting elements (toys in a box or a full closet), overlapping (drawn) figures, finding parents (or someone else) in a crowded situation (schoolyard, store), finding a coat on a crowded rack.
- Difficulty in looking up and down from textbook to exercise book and vice versa.
- Withdrawn or instead boisterous in new or crowded situations, such as in the schoolyard or a supermarket.

Compensation can consist of:

- Reducing the viewing distance in the case of crowded pages

Social problems can occur when:

- Being zoomed in too much (overlap with autism-related characteristics).
- Seeing no links between what happens in the schoolyard, etc.
- Difficulty in recognising faces or emotions.

Visual identification

Ability to recognise pictures, photos, objects, symbols, etc. Examples of situations that children may find difficult when their visual identification ability is impaired include:

- Difficulty learning geometric forms (triangle, square, circle, oval, etc.)
- Difficulty mastering word pictures
- Recognising people: in daily life, from photos
- Recognising emotions and facial expressions of persons: in daily life, from photos
- Difficulty understanding and/or identifying three-dimensional objects, photos of objects, detailed coloured drawings or pictures, line drawings (black-white), emotions on faces (some or all), colours or forms (some or all)
- Difficulty recognising or identifying objects, pictures, letters, figures, faces.

Visual spatial functions

Ability to recognise directions, to place elements in relation to each other, to observe movement. Examples of situations that children may find difficult when their visual spatial functions are impaired include:

- Difficulty with spatial orientation; difficulty in finding the beginning of a line on the page; cannot find their way independently, even short distances.
- Difficulty determining whether an object is moving; difficulty estimating the speed with which an object moves, e.g. how fast a ball is coming at you.

- Difficulty recognising/identifying objects from a moving vehicle; difficulty recognising/identifying moving objects.
- Difficulty determining where an object is in relation to another object, or how two objects are oriented towards each other.
- Difficulty mastering letters and/or numbers.
- Difficulty with the concept of visual-spatial figures (copying a drawing or imitating an object).
- Difficulty estimating the direction of lines.
- Difficulty telling time (on analogue clock).
- Difficulty with spatial relationships.
- Difficulty with the concept of mirror images.
- Difficulty with orientation, finding your way.

Visual motor functions

Difficulty making accurate and/or quick targeted movements, with converting visual information at high speed and without having to think for an accurate movement. Examples of situations that children may find difficult when their visual motor functions are impaired include:

- Grabs or reaches next to an object.
- Frequent little accidents with picking up food or drink.
- Slow in targeted movements.
- Difficulty catching a ball.
- Difficulty aiming a ball.
- Difficulty hitting a ball with the foot and/or kicking it in the right direction.
- Difficulty drawing the right direction of lines.
- Difficulty writing neatly (lines and letters are warped and they wiggle).
- Frequently bumps into others or objects.

- Looks away with targeted actions.
- Difficulty with eye-hand or eye-foot coordination.

Visual (storage) memory
Where and what was it? The storage location of visual information. Ability to form (or deform) a visual image ("image database") Examples of situations that children may find difficult when their visual (storage) memory is impaired include[1]:

- A lot of repetition is needed to remember visual information.
- Difficulty with free drawing.

Pace of visual information processing
The speed with which someone can respond to visual information. Needing more viewing time to process visual information. Examples of situations that children may find difficult when their pace of visual information processing is impaired include:

- Difficulty reading subtitles.
- Difficulty following quickly changing situations (e.g. in traffic, gymnastics, films).

Other relevant functional areas

- Executive functioning.
- Attention (discussed above).
- Intelligence level.
- Behavioural factors.
- Motor system.
- Sensory information processing.

Children may also find it difficult to process simultaneously various sensory stimuli.

- Looking away while listening intensely.
- No eye contact during conversation.

[1]Experience: the pink elephant exercise

- Steering an action visually, but looking away from the place of action when an object is positioned.

5.3 The CVI Passport

<table>
<tr><td colspan="2">CVI Passport
Name
Age</td></tr>
<tr><td colspan="2">CVI is a collective name for visual impairments that result from damage to or abnormal development of the brain. The impairments and limitations falling under this category relate to the processing of visual information by the brain. Perception involves both the eyes and the brain. The list below contains a description of the various visual functions that are impaired in [name]. First, we state the functions that are involved primarily with the structural integrity of the eye. Following that, we list the functions that are involved in the processing of visual information in the brain. Of course, theres always an interaction between the eye and the brain in processing the visual world around us.</td></tr>
<tr><td colspan="2">Low visual functions
The low visual functions directly relate to the eye (compare this to a camera).</td></tr>
<tr><td>Visual sensory functions: these are the functions of the eye itself, such as the ability to see sharply, to signal information by means of peripheral vision, to observe colours and contrasts, and to estimate depth and distance.</td><td>• Visual acuity
• Range of vision
• Colour perception
• Contrast sensitivity
• Depth perception</td></tr>
<tr><td>Oculomotor functions: these functions determine the ability to direct the eyes properly.</td><td>• Fixation
• Smooth-pursuit eye movement
• Accommodation</td></tr>
</table>

High visual functions The high visual functions relate to the processing of visual information from the eyes in the brain (compare this to a computer that processes the images).	
Visual selective attention: this determines on which visual information from the field of vision (the eyes) the brain is focused.	• Global visual selective attention • Local visual selective attention • Selection of a specific property
Visual identification: The ability to recognise directions, to place elements in relation to each other, and to observe movement.	
Visual spatial functions: The ability to recognise directions, to place elements in relation to each other, and to observe movement.	• Location perception • Orientation perception • Movement perception (movement, direction, speed)
Visual motor functions: the ability to convert visual information at high speed and without thinking into an accurate movement.	
Visual (storage) memory: Where and what was it? The storage location of visual information. Ability to form (or deform) a visual image (image database).	
Pace of visual information processing: The speed at which a person is able to respond to visual information.	

Other relevant areas	• Executive functioning • Attention • Intelligence level • Behavioural factors • Motor system • Sensory information processing
What can we do about it?	
Compensation by [name] him/herself	• Description of personal strengths • Description of positively developed functions
Adjustments in immediate surroundings	• How can others help me see better?
Devices	• What can help reduce my problem (spectacles, computer, etc.)?

Table 5.2: The CVI Passport

5.4 Example of the keycard

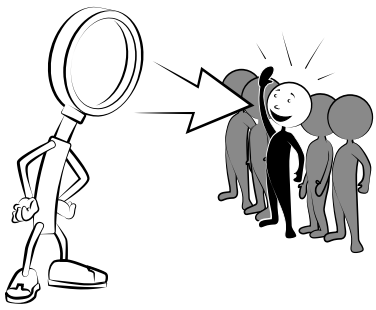
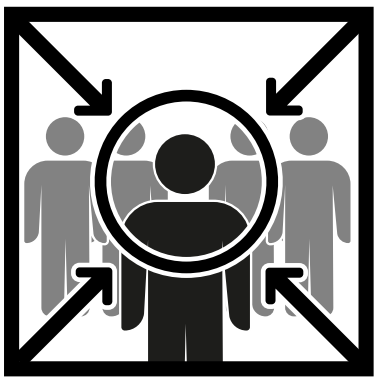
Subnormal vision (0.6)	
	
A disorder in local visual attention	
	

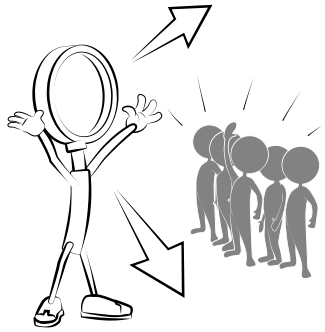
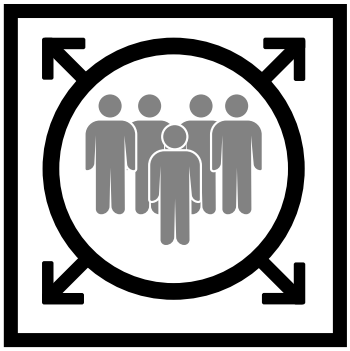
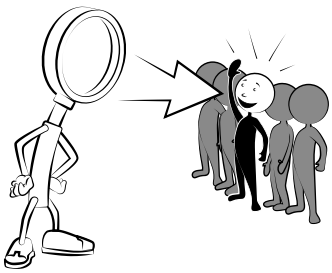
Table 5.3: Example of keycard (front)

Visual difficulties (max. 4)	
Qualities	• Perseverance • Positive attitude • Will to do right • High motivation
Compensation strategies	• Intelligence (quickly adjusts to advice) • Viewing strategy
Adjustments / devices	• Materials on fixed places • Routes are learned in advance • Opportunity to choose a calm place during noisy / busy situations like a party

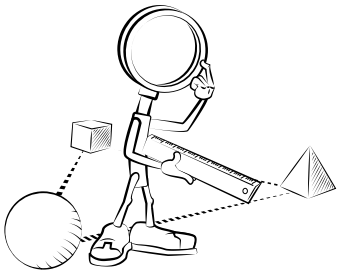
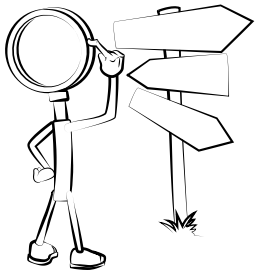
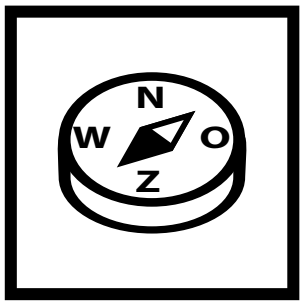
Table 5.4: Example of keycard (reverse)

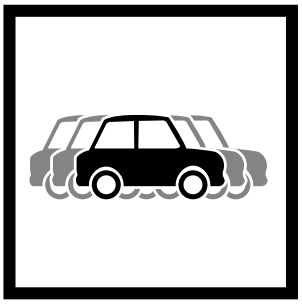
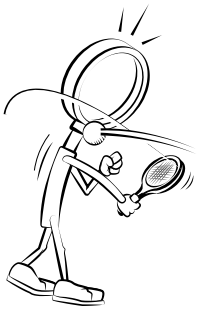
5.5 Symbols

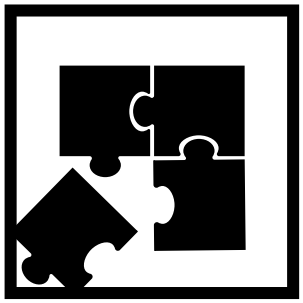
There are different illustrations and more abstract symbols designed to be used in the passport or the keycard to illustrate the different high visual functions. The choice has been made to create pictures which point out the function and not the difficulties encountered by a client with CVI. In the glossary beneath, you will find a short description about how the symbols are created [2].

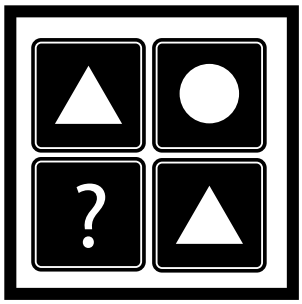
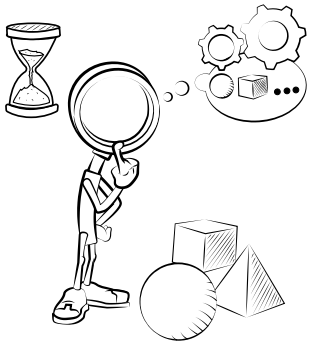
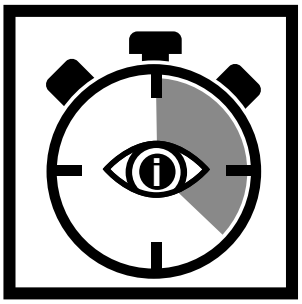
HVF	Illustration	Symbol
Global visual selective attention		
	The "loop" person is focused on a wide array of the visual field, not seeing the details in it (details are not sharp).	
Local visual selective attention		
	The "loop" person is totally focused on just a small detail in the group of people. The rest is perceived less sharply; connections between the visual details get lost.	

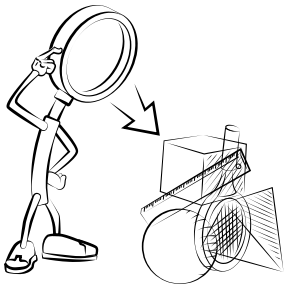
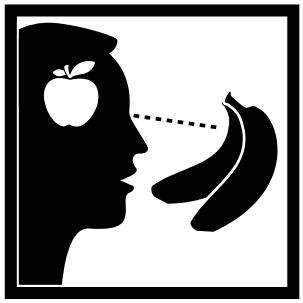
[2]HVF: High Visual Function

HVF	Illustration	Symbol
Visuospatial functions: Location perception		
	The "loop" person has a ruler to measure the spaces between the different forms to define where each object is. Pointers (Google Maps) are used to describe locations.	
Visuospatial functions: Orientation perception		
	The "loop" person is figuring out what the signage means, which direction is the right one? The abstract icon is a compass pointing in a direction to indicate the orientation perception. What is the right direction?	

HVF	Illustration	Symbol
Visuospatial functions: Movement perception		
	The car is moving, as indicated by the different lines. The "loop" person sees a moving car and knows in which direction it is moving. The icon consists of a moving car.	
Visuomotor functions: Eye hand coordination		
	The "loop" person tries to hit the ball with a racket but misses: wrong estimation of where the ball is in relation to his hands. The icon shows an eye and hand to indicate their working relationship.	

HVF	Illustration	Symbol
Visuomotor functions: Eye foot coordination		
	The "loop" person tries to kick the ball but misses: wrong estimation of where the ball is in relation to his feet. The icon shows an eye and foot to indicate their working relationship.	
Visuomotor functions: Eye foot coordination		
	The "loop" person is trying to draw a tree as it is described by someone nearby. The radars indicate the process of visualising a tree in the memory. The working memory is necessary to mentalise if the bit of the puzzle which is left fits or not.	

HVF	Illustration	Symbol
		
	The icon assembles a memory game where the last part still has to be visualised.	
Visual processing speed		
	The "loop" person is trying to comprehend the different forms. The hourglass defines the time passing to process this visual information: only two out of three are already processed. The icon is a watch with an eye insight. The I stands for information. The grey area indicates time is needed for information processing away from the eye.	

HVF	Illustration	Symbol
Visual agnosia		
	The “loop” person is figuring out what he is seeing. He sees the objects but isn’t able to name them / doesn’t know what he is seeing. The icon represents the mental change in not recognising the object.	

Conclusion 6

As we deepen our understanding of visual impairment in childhood, it becomes more evident that cerebral visual impairment (CVI) is becoming a public health problem in developed countries. The CVI population is a problem with enough impact at European level to demand our attention as professionals. The difficulty of quantifying the population or percentage of the population that can be included in this category is partly due to the complex assessment process required for this purpose. This project has aimed to provide knowledge and strategies for multidisciplinary assessment of this group of patients affected by CVI with visual impairment. However, this has only been the first step along a long learning path.

This handbook is the product of many hours of professional and personal dedication, including different perspectives and some difficulties, taking into account that these children present alterations in the cortical areas the task of which is the transmission and interpretation of visual information.

The question to which this project has tried to respond is how we can evaluate these children in a comprehensive way. This is the key question that parents, teachers and therapists involved in their education and therapy often ask. They expect an answer that will help them develop a better understanding of their children. Starting from the framework of the International Classification of Diseases (ICD), in order to establish a clear and common starting point for the main concepts, this project has focused on the development and implementation of a process of assessment of these items, which in turn generates global baseline information to which we can compare the evolution of our interventions over time.

The assessment goes beyond measuring visual function using traditional tests such as visual acuity, visual field or contrast sensitivity. The assessment transcends the purely physiological visual function, performing

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a holistic approach, a perspective counting on years of expertise in the field of a multidisciplinary team: optometrists, neuropsychologists, occupational therapists, low vision specialists, and other professionals involved in the process.

The products of this project have been developed from a holistic intervention approach, which also requires the collaboration and participation of parents and educators. If there is one thing we want to stand out, it is that all the professionals involved have learned throughout this process. But also it is that each assessment, each child, requires a significant amount of time. This investment of time is intended to be not only for individualised assessment, but also to collect and transmit proper and significant information from and to parents and teachers, educators, speech therapists, psychologists, etc. Therefore, one of the main conclusions of this project is the importance of continuous and regular information exchange throughout the period of intervention with the child with CVI.

We hope that this Handbook will support and help professionals who wish to approach the field of neuro-visual disorders in the near future. We hope that the tools included here will serve their purpose and enrich the intervention of less experienced professionals in CVI.

We would also like to stress that the experimental phase of this project has played a decisive role in the final development of this manual, not only because of its length and complexity, for the final selection of tests included in the handbook, but also because of the self-regulation of the process. The publication of this manual is enriched by a great number of observations that professionals of different profiles from different European countries have contributed, all derived from their own professional experience.

Therefore, we understand that in our objective of trying to decode and evaluate how children with CVI see themselves, to provide them with the best possible care, appropriate to their personal and family situation, we now have, as professionals, specific tools that will, in the future, help other professionals to select the proper tests of assessing and advising both these children and their families.

Finally, we are pleased to have carried out this multidisciplinary, transnational and intercultural work and to have provided a European instrument to help other specialists in the field. This project has not only provided us with explicit professional experiences but it has also allowed us to gain personal skills and to grow as individuals.

We also thank all the partners and silent partners involved in the implementation of this project for their dedication, their enthusiasm, their hours of work, their constructive discussions, and, above all, their great professional and human qualities.

We are also grateful for the financial support that the Erasmus+ Program (2015-1-FR-KA202-015120) has offered to us in order to implement this project and to provide our society with our grain of sand in this field of knowledge.


C V I

Appendices 7

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7.1 Daily life tests

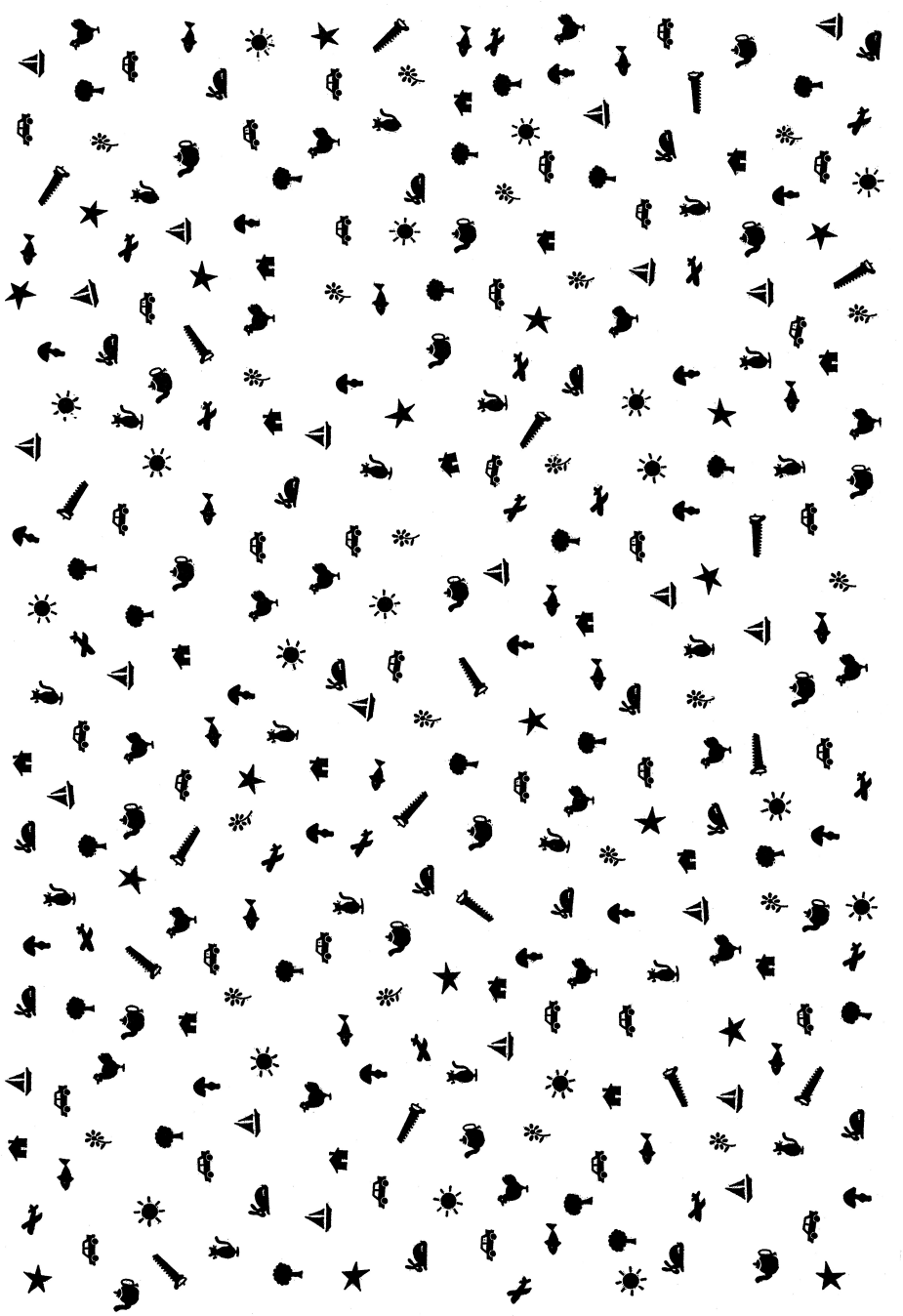

Figure 7.1: Car test

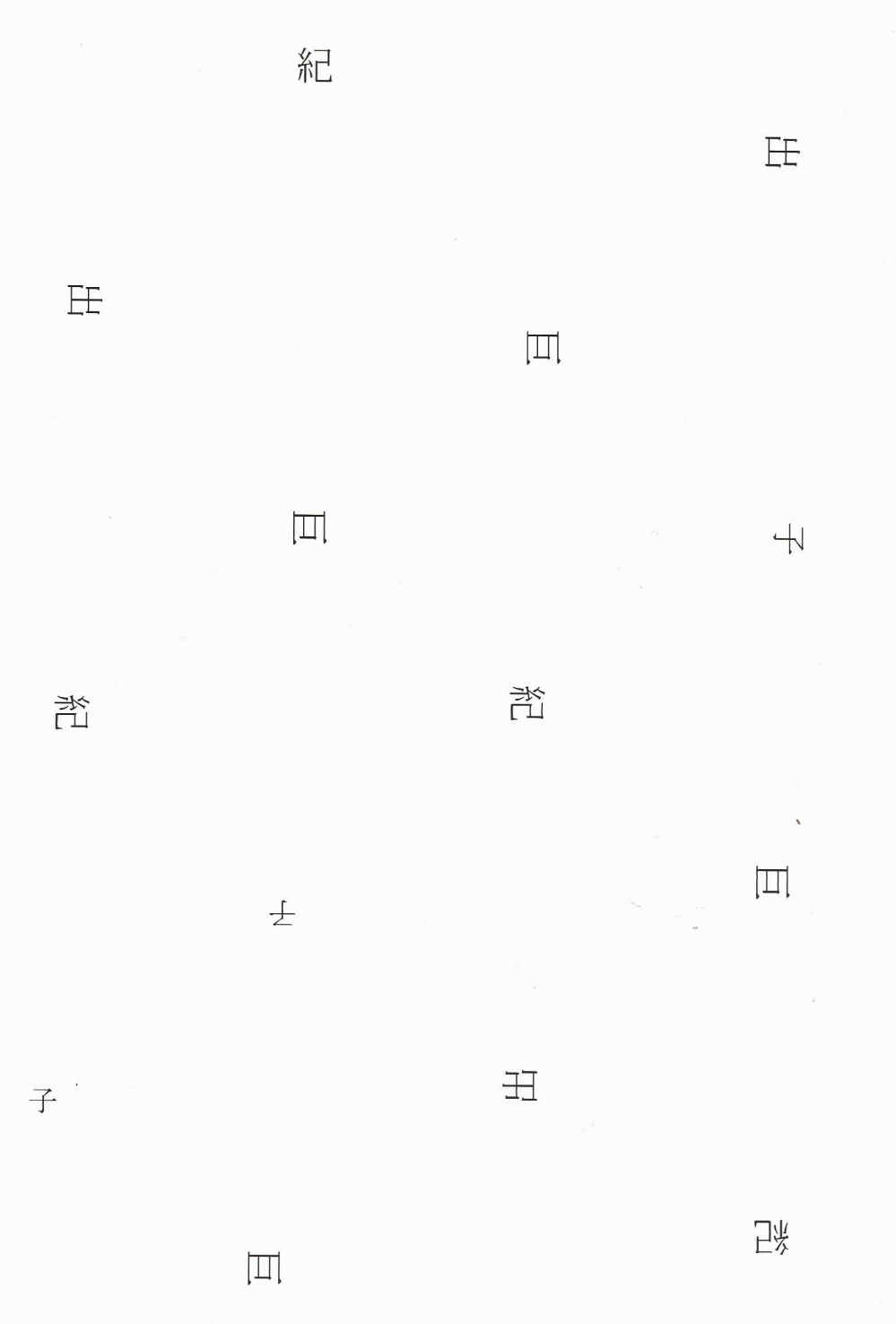

Figure 7.2: Chinese letters test

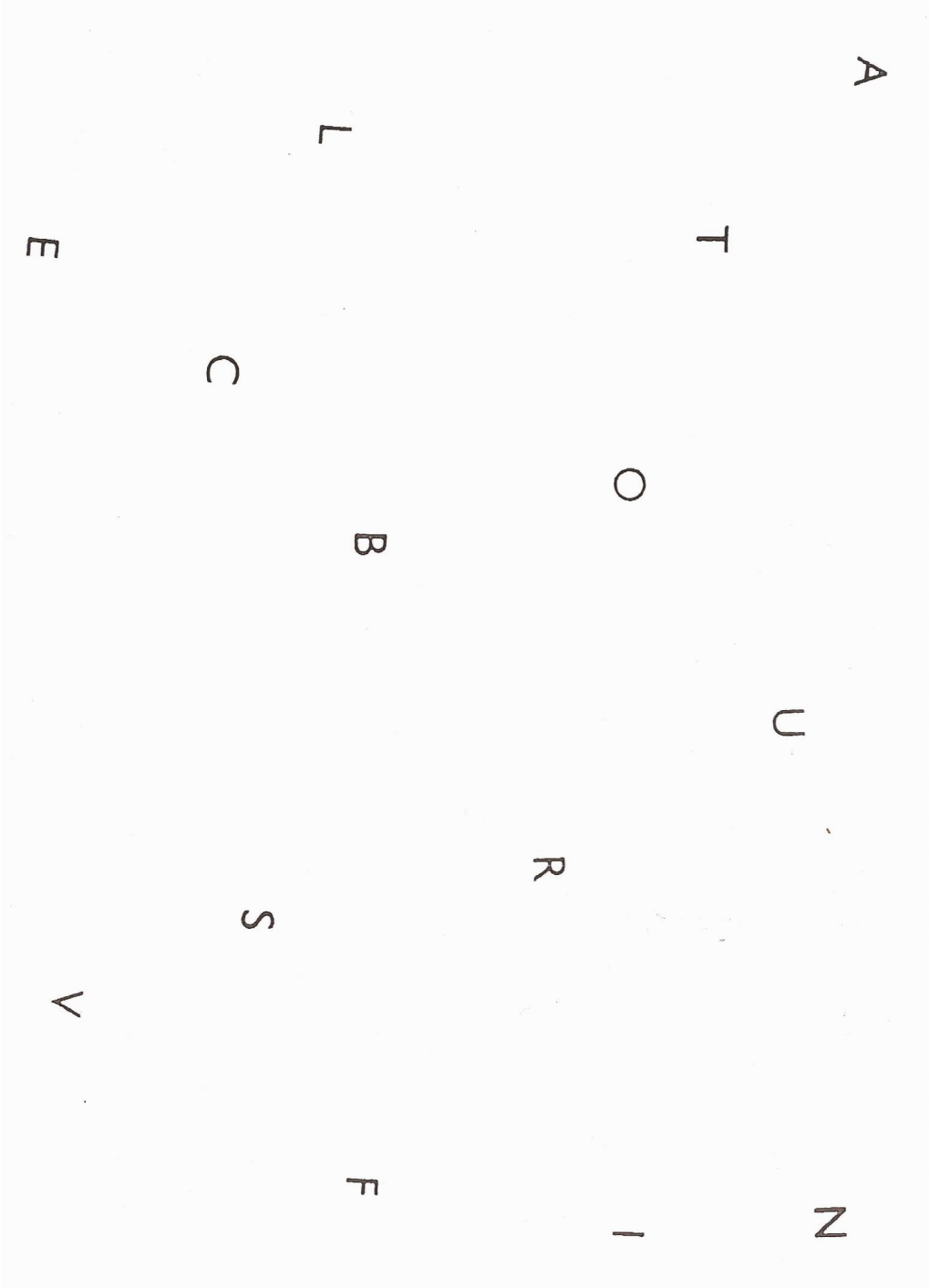

Figure 7.3: Letters test

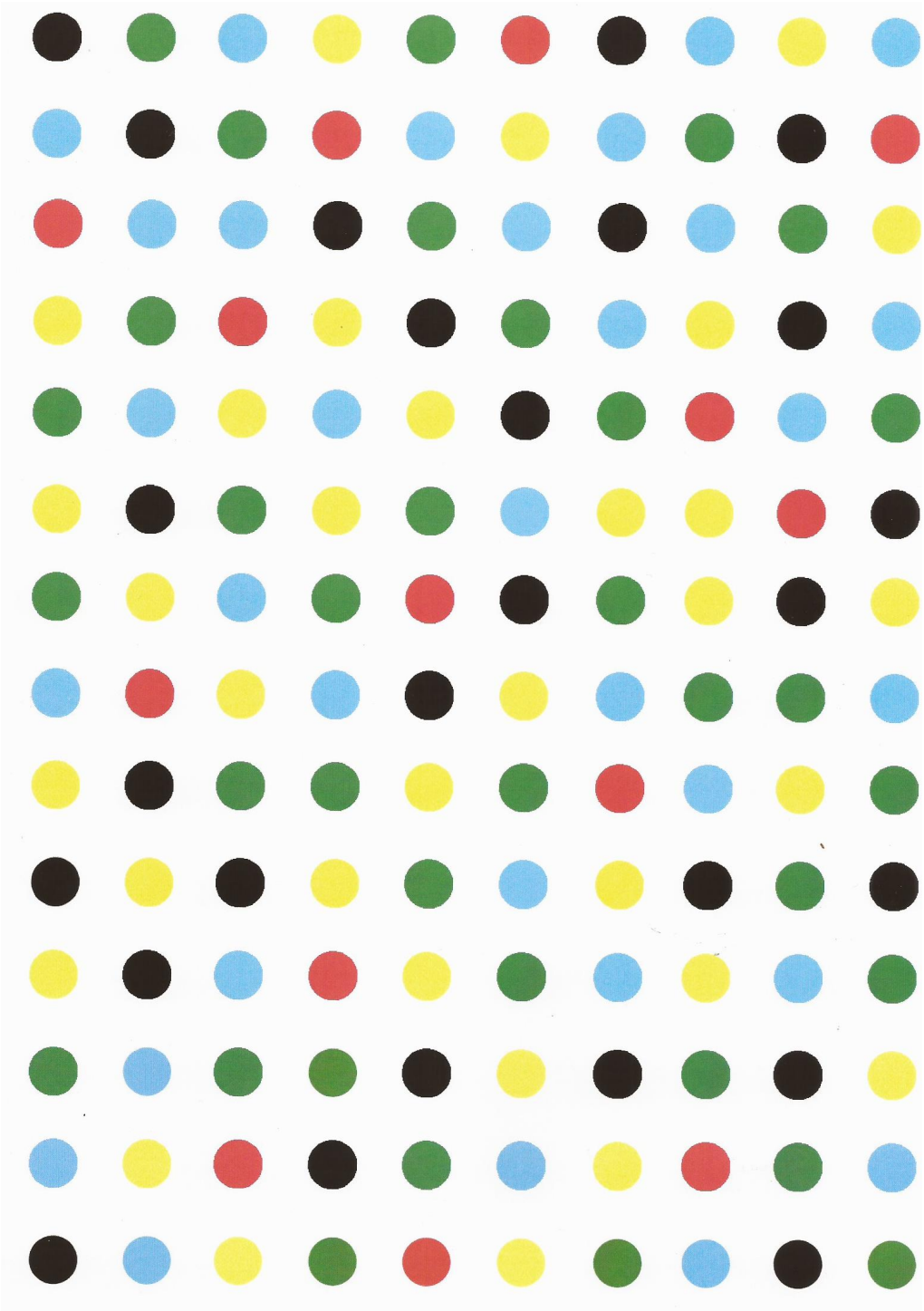

Figure 7.4: Red Dots test

7.2 Intellectual Property Rights

Grant of Permission to Use Copyright Work

Dear Sir,

We write in response to your request dated [3/05/17] for permission to make use of various copyright works in your handbook for the Erasmus + project about CVI with low vision.

We hereby grant permission for you to copy and publish the copyright works specified in your request in print format and to make them available over a secure web environment. The copyright works may not be amended or altered in any way. This permission is granted for this educational purpose only and will not extend to the use of the copyright works for non-educational or commercial purposes. An acknowledgement of the source and ownership of the work must be included in any use made of the work.

Yours faithfully,

[name of copyright holder] Valérie BARRAY

Figure 7.5: Car test and related article

* 8

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