Practical Low Vision

Ophthalmic Optics Files

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Authors
Geneviève Prévost
With contributions from Dominique Martin
Coordination:
Dominique Meslin, Essilor Academy Europe
With contributions from Anne Catherine Scherlen
And contributions from:
Mo Jalie and Geoffroy Meynet
for the English version

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Introduction

Certain ocular conditions, frequently of a degenerative nature, cannot be treated. They often lead to poor vision and sometimes to blindness. This impaired vision can lead to handicaps for the person in every aspect of their life, reducing efficiency in everyday activities, increasing the risk of falls or accidents and cutting them off, little by little, from any social, cultural and sometimes even family life... This adds a real human problem to the sight loss.

Faced with this situation, we can only place our hope in research and medical progress to improve the comfort of people affected by such distressing conditions. However, in spite of the considerable progress made in recent years, there are still no solutions for a permanent cure. Today, rehabilitation for people with sight loss remains essential if they are to retain a certain quality of life and continue to carry out some of their activities independently.

The Specialists in Low Vision play an essential role in this rehabilitation process. Their task is to optimise the quality of the person's retinal image and offer them vision aids appropriate to their visual condition, the tasks that they wish to accomplish and the conditions in which they carry them out. They work in close conjunction with the various parties involved in the rehabilitation process.

Visually impaired people are more numerous than ever...

Since degenerative ocular conditions most often develop with age, the number of visually impaired people continues to grow. With life expectancy having increased over the last decades, the number of people affected by age-related macular degeneration, for example, is growing rapidly. The World Health Organisation (WHO) considers that, in European countries, one person in four is affected over the age of 75, which represents a large population.

...but too few practitioners concern themselves with Low Vision

Today, too few professionals provide a low vision service, although it is essential to the population. The reasons most often cited are the technical complexity, the time that has to be devoted to it, the cost of equipment and the low profitability.

We should pause for a moment and consider all these frequently heard ideas.

- Determining the vision aid required by a partially sighted person does indeed require real "know-how". But adequate training allows the necessary skills to be acquired.
- Providing service to visually impaired person takes time because of the lengthy, but essential, communication process and the time required for the person to adapt to the various constraints resulting from their visual condition and the new aptitudes to be acquired. This time is quite similar to that devoted to adapting contact lenses.
- The cost of vision aids is a point often raised by visually impaired people. However, before considering sophisticated and costly equipment, we should remember that there are numerous simple aids that are effective and economical, if well chosen.
- The profitability of the low vision activity is an important concept. Admittedly, an initial investment is necessary but it should be considered in the light of the significant future growth potential that the activity presents. We should also mention that, where the Low Vision Specialists develop a positive image as a practitioner with a high level of technical capability in low vision, this will undeniably make a positive impact across their entire business.

Finally, if there is a field where Eye Care Professionals can assert themselves as real eyesight and health professionals, it is indeed the low vision area. It is an opportunity for valuable contacts with other health professionals and an opportunity to work with them to achieve a noble purpose: that of helping visually impaired people, most often the elderly, to "see better to live better".

The purpose of this "Practical Low Vision" Ophthalmic Optics File is to assist professionals who wish to start a low vision activity or perfect their skills in this field. It presents a method of rehabilitating visually impaired patients, proven over more than twenty years of practice and training. This method, simple and pragmatic, allows a great majority of people to regain a certain level of independence and the enjoyment of "doing things for themselves".

While this File does not pretend to deal with all aspects of rehabilitation for visually impaired people in an exhaustive manner, it does seek to provide eye care professionals with the basic knowledge necessary and essential for specialising in the field of low vision correction.

More simply, it seeks to make a contribution towards creating ever greater interest in the practice of low vision treatment and to give rise, among eye care practitioners, to more and more vocations and motivation to serve and help visually impaired people.

Low Vision, a Human Problem...

A few comments and requests often made by visually impaired people during their initial consultation:

"I came to see whether you can give me stronger glasses; I can't see to read very well any more."

"I can't see anything any more; I can no longer do anything."

"I want a magnifying glass for reading."

"The doctor told me my eyes are worn out."

"I can't read any more; I have cancelled my newspaper subscription."

"I can no longer see what's on my plate."

"Nowadays, I refuse to eat in restaurants or at friends' houses; I have too many accidents when I'm eating."

"I would like to carry on taking the train every month, as I used to, to go and see my grandchildren in Turin."

"Every Wednesday, I used to give my grandchildren a treat but I can't make cakes any more.»

"My children don't leave my grand-children in my care any more. They say it's too much for me now."

"I don't recognise people in the street any more."

"I used to do a lot of knitting for my grandchildren. I stopped... the things I make don't look right, I drop stitches or make mistakes when narrowing and things like that."

"I don't recognise people in the street any more."

"I don't watch television any more; I listen to it."

"I don't dare go out shopping on my own any more."

"I can't see people who say 'Hello" to me any more. They think I've become really grumpy because, obviously, I don't answer them."

"I've worked hard all my life. I thought I would read as soon as I had more free time, but then, six months after I retired, this happened to me."

"I can no longer see whether I have stains on my pullover; I have to ask my cleaning lady!"

"I can't cut my nails any more; I cut myself... I make such a bad job of it. It's very difficult to ask someone else to do it for you."

1. Visual Impairment

Figure 1: *"Seeing poorly" can take many forms.*

Visual impairment creates a particularly incapacitating disability that considerably reduces the potential for cultural, artistic, professional and learning experiences. It compromises people's safety in their movements and also their effectiveness in daily life. It destroys their quality of life. The impairment often results from age-related diseases that can be neither treated nor cured. Gradually or suddenly, they destroy certain parts of the eye and irremediably impair the vision of the person.

A person is referred to as visually impaired if his/her binocular visual acuity is less than 20/60 (6/18) and it cannot be improved by conventional means such as spectacles, contact lenses or refractive surgery.

Thanks to prevention and screening, diseases causing blindness in children and young adults tend to be less common. On the other side of the spectrum, there is an increased incidence of age related conditions affecting our ageing population.

These various ocular conditions, discussed later, will affect the person's sight in different ways. We are accustomed to saying that there are "several types of poor vision" and that a person can experience very different problems, depending on their general situation and the conditions under which the symptoms develop. Depending on where alterations take place, quite specific functional disorders arise, highlighted by the assessments that we present in sections 2 B and 4 B.

a. Disorders of the central vision generally cause loss of visual acuity in both distance and near vision, frequently associated with a central scotoma - i.e. full loss of vision in a defined area of the central field of vision -, impaired perception of colours or depth, inability to read or write, loss of precise hand-eye coordination and an incapacity to recognise faces. They give rise to difficulties in directing one's gaze and sensations of loss of balance when walking.

b. Disorders of the peripheral vision cause a reduction in the field of vision that can reach the stage of - extremely reduced - tunnel vision, impair the perception of movement and affect night vision and the ability to recognise shapes and contours. They can affect spatial orientation to the point of creating a partial or total inability to move around.

c. General disorders comprise the disruptions caused by both types of impairment mentioned above. They create physiologically significant impairments. We will come back to this.

There are three phenomena that should be mentioned here because they are independent of the type of impairment and affect the great majority of people with sight loss : glare, the phenomenon of completion and the psychological factor.

1. Glare

Glare is a problem caused by excessive light. Certain pathologies create an extreme sensitivity to light and therefore cause photophobia, i.e. the experience of ocular pain due to light. Figure 2 shows how bright surroundings that would appear cheerful and sunny to most people are a source of visual discomfort to a visually impaired person, since their visual perception is considerably reduced by the blinding effect of the light. We should note that adapting to darkness is also generally long and difficult; it takes time and, in very many cases, causes discomfort.

Figure 2: *Importance of glare to a partially sighted person:*

a) What a scene from daily life looks like to most people.

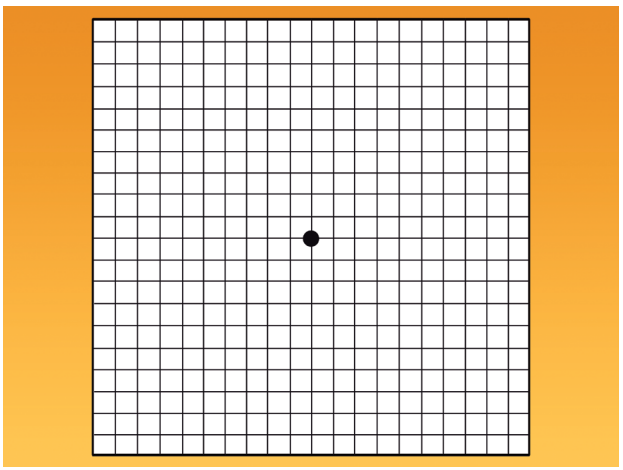
b) Example of how it is seen by a partially sighted and photophobic person.

2. The Phenomenon of Completion

We frequently observe a discrepancy between the results of tests aimed at measuring sight loss in an objective manner and the subjective view of the person suffering from the loss. This phenomenon is a physiological mechanism of cerebral plasticity that consists in reconstituting a shape or filling up an area that is not actually seen in its entirety due to the objective scotoma. In the case of macular degeneration, for example, the perceived central scotoma is often smaller than the extent of the macular lesion would lead us to believe. The information received by healthier retina adjacent to the macular lesion is given priority by the cerebral cortex and this often allows the patient to hide the central blind spot completely or perceive a smaller "deleted area" than the original scotoma. This cortical plasticity is based on adaptive mechanisms and explains the successful development of compensation by rehabilitation.

Subjective scotoma may be visualised with an Amsler grid, shown to the visually impaired person who is then asked whether the grid can be seen in full or whether one or more sections are missing.

Figure 3: *The Amsler grid:*



This test may be carried out in either monocular or binocular vision. The former allows the assessment of the perceived scotoma for each eye and the latter enables assessment of the area of visual efficiency. In both cases, the person fixates on the central point, indicates any missing part of the grid and traces its contour.

3. The Psychological Factor

The psychological state of a patient who is requesting a low vision aid cannot be dismissed. The shock of being told the diagnosis, and especially of learning that the disease cannot be cured, leads to psychological repercussions, with a characteristic path that cannot be avoided. This must be recognised and respected by the low vision professional, failing which, rehabilitation will not occur under the best conditions and will not give the expected results.

The Main Stages along the Psychological Path.

The "grieving process" following any loss is characterised by three phases. This psychological mechanism is a normal mechanism of adaptation to a loss that cannot be alleviated.

a) **Distress:** this is the shock, the denial: "It cannot be possible...", "I haven't lost anything", which occurs when the bad news is given.
b) **Depression:** this is the disorganisation, the time when the person confuses what they have lost with their very selves: "I've lost everything...", "I have no value any more...". Their self-image is called into question.
c) **The Upward Turn:** then comes the period for restructuring, reacting, adapting, and understanding the functional extent of the deficiency and the resulting disadvantages and incapacities. The person reconstructs an image of their functional self and is ready to "make the best of it".

This path is normal, long and painful. Each person goes through the various stages at their own pace, depending on their past, their history and their personal resources as well as on the assistance and support that they receive.
The issue for the patient is to re-invest as widely as possible in areas of established skills and perhaps explore other skills and interests that have not previously been developed much. The help to be provided is therefore functional and technical and falls entirely under the responsibility of the relevant professionals.

The Importance of the Quality of the Interview.

The interview with the visually impaired person provides several elements essential to their care.
Firstly, by describing their loss, whether sudden or progressive, what they can still do and what they can no longer do, the patients give us an idea of what is most important to them and help us to define a plan for them. We also learn how they react to the onset of the impairment and the stage they are at in the grieving process.
This time also allows the Low Vision Specialists to adopt the right professional attitude and find the proper way to communicate, to adapt themselves to the person and to provide the explanations, encouragement and support along the way to the best of their ability. Care should be taken to avoid being condescending or overprotecting and to treat the person as a responsible adult. It is important to take into account their experience, their previous professional and recreational activities, their intellectual level and their cognitive capacity. This allows us to make use of the mental structure, the fundamental process of categorisation in the acquisition of knowledge, the capacity for abstraction, the imaginary, access to mental pictures and any inner vision that helps compensate for a visual shortcoming.

Finally, we should note that these periods of reconstruction form part of therapeutic cycles in which the wishful thinking keeps coming back, always triggering the expectation of a miracle, the disappearance of the problem or a cure, the vain hope of "seeing again as before", the dream of it all going away. This inner vision is used and developed when you can no longer have full confidence in incomplete visual information. All representations of self and conceptualisation are then more correct and based on a number of experiences.

A few typical reactions from the psychological stages gone through after being told the diagnosis, gathered when vision aids are being proposed and tested:

- No need for them because "I have injections".
- Using a system, reading, ... will "damage what little sight I have left".
- Not really needing the product, preferring to go without rather than make the effort to learn how to use it.
- Finding that the system is too difficult to use: "I can't read like that."
- Loss of appearance, no longer being "like everyone else".
- "Spending so much now..."
- Secondary gains (visits, protection by relatives, etc.)

2. A Few Notes on Visual I

A About the Eye and Vision

The eye is the peripheral organ of the visual system. Its main role is to focus the image of scenes looked at onto the retina by converging the rays of light and to translate the light message into a nervous message, which is sent to the central nervous system.

1. Description of the Eye

The external envelope of the eye, the sclera, is spherical. It surrounds and protects the middle layer, the choroid, a pigmented and vascular layer that covers the back of the eye and supplies blood to the retina and more particularly to the macula, which is deprived of blood vessels. The internal face of the eye is covered by the retina composed of two layers:

a) *The superficial* layer is nervous tissue that includes the light-sensitive cells, the cones and rods cells, which provide the "transduction", i.e. the encoding of the visual information in the nervous message and also the initial processing of the information.
b) *The Retinal Pigment Epithelium (RPE)* of the retina contains melanin pigments that absorb unwanted light rays and ensure the renewal of the light-sensitive pigments.

The anterior and internal parts of the eye are transparent. The main focusing element of the eye is the cornea, which forms the interface with the surrounding air. After passing through the cornea, the incident light crosses the anterior chamber filled by the aqueous humour. Part of this light rays passes through the pupil formed by the diaphragm of the iris and then the crystalline lens, a variable-power convergent lens, which, together with the cornea, serves to focus the image on the retina. The image thus formed, may be encoded by the visual receptors.

2. The Retina, Nerve Tissue

The retina comprises several layers of nerve cells. The light passes through the various layers of the cells before being captured by photoreceptors.

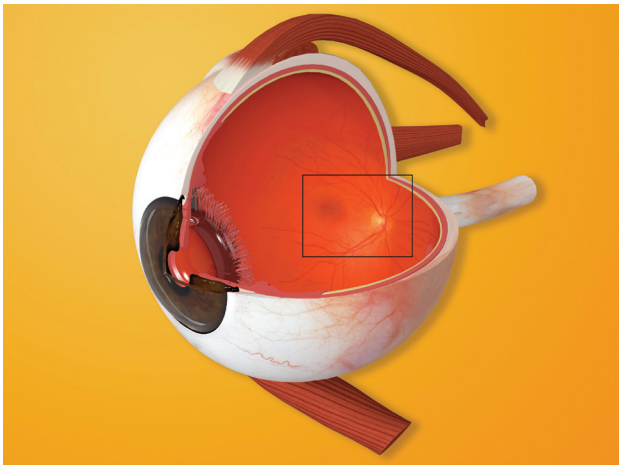
The density of neurons varies, depending on the sector of the retina: in the central part, the macula, which measures approximately 1.5 mm in diameter, is completely free of blood vessels but is supplied by those in the choroid. At the bottom of the macular depression is the fovea. In this location, aligned with the optical axis, light rays fall directly onto the photoreceptors, exclusively cones. This is the region of the retina where visual acuity is at its highest. It measures approximately 300 microns (0.3 mm) in diameter.

As you move away from the optical axis, the integration neurons are arranged in successive layers. Horizontal, bipolar, amacrine and ganglion cells only appear from the foveal rim and cone cells are then progressively replaced by rod cells. These anatomical characteristics are behind the main functional differences between the "central retina" and the "peripheral retina".

On the nasal side of the fovea is the optic disc, the starting point of the optic nerve, sometimes called the optic nerve head. The retina is interrupted at this spot, creating a small natural scotoma, known as the blind spot.

The peripheral retina covers the whole back of the ocular globe. It is essentially made up of rod cells. The number of photoreceptors connected to a ganglion cell is much greater here than in the central retina. This has the effect of allowing movement detection and increasing sensitivity to light but at the cost of poorer visual acuity.

Figure 4: *Anatomy of the eye:*



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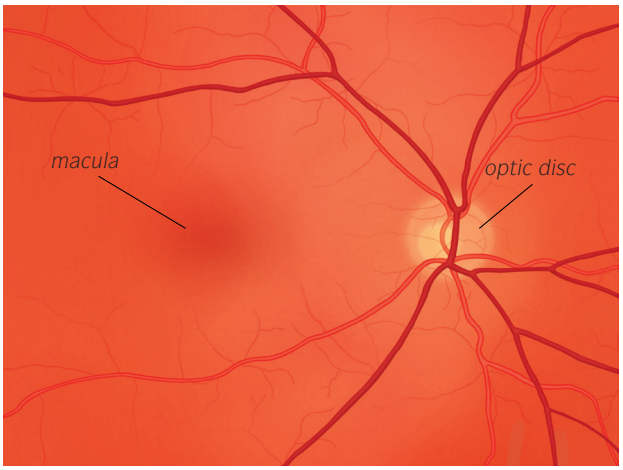
a) Cross-section of the eye.



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b) Fundus of a normal eye.

3. Photoreceptor Cells

Cones and rods cells have different functions in the visual system. The cones encode visual information in daylight (photopic) and provide colour perception. Rods, much more sensitive in dim light, take over when the cones no longer function. They allow the retina to adapt to darkness. Rods contain much more photosensitive pigment than the cones and the renewal speed of the rhodopsin-containing discs is much higher.

Encoding and Processing Visual Information

The phototransduction, i.e. the transformation of the retinal image into nervous impulses, takes place in the external segment of the visual receptors (the internal segment looks after the cell's life). These external segments enclose the photosensitive pigment, the rhodopsin, composed of a protein called opsin, to which is attached retinal, an aldehyde of vitamin A, derived from food and delivered by the circulatory system. Under the effect of light, the chemical structure of retinal is modified, creating an electric potential difference, which propels an electrical current through the bipolar and ganglion integration cells, and then along the optic nerve to the cortex. The cones allow for the colour vision, thanks to three types of receptor, differentiated by their absorption spectrum: the ones that essentially absorb short wavelengths (S "blue" with an absorption peak of 420 nm), the ones that absorb medium wavelengths (M "green" with an absorption peak of 530 nm) and the ones that absorb long wavelengths (L "red" with an absorption peak of 560 nm).

Processing the Information

The horizontal, bipolar, amacrine and ganglion cells participate in the integration of the information coming from the visual cells. The axons of the ganglion cells constitute the optic nerve, which projects images onto the cortex, these images having passed through the chiasma, lateral geniculate nucleus and superior colliculus, different areas of preliminary analysis of the image (figure 5 b).

4. Eye Movements

Eye movements are another indispensable aspect of vision, since they modify the image formed on the retina. They are performed by the oculomotor muscles, fixed on one end to the sclera and on the other end to the inner part of the orbit. They enable vertical, horizontal and rotational movements of the globe and are controlled by specific nerve centres located in the central nervous system.

Vergence movements allow the gaze to fix on an object. In effect, these are movements that the eyes make when you want to look at an object located within the field of view. They allow the image of the object to be brought onto the fovea in each eye.

Saccades are rapid movements of the eye. These are the movements that the eyes make when they explore the panorama. The amplitude of the angle varies from a few minutes to a few degrees and their duration is 10 to 80 milliseconds.

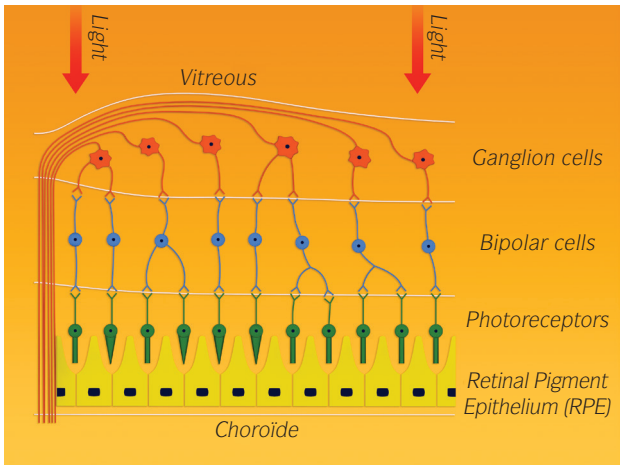
A smooth pursuit is a slow, involuntary and automatic eye movement that you make when you follow a moving object. It is produced without latency time, so that vision is never interrupted.

The (optokinetic) *physiological nystagmus* is a complex movement made up of pursuits and saccadic recall movements. It can be seen, for example, in a person who is looking at a landscape through the window of a moving vehicle. The nystagmus allows part of the visual scene to be followed, before return to another fixing point, which, again, is followed, and so on.

We should note that:

- Vision is only possible because the eyes are permanently animated by *micronystagmus*, a stimulation refreshment movement essential to perception. If there were no such constant imperceptible movement of the eyes, perception would be extinguished.
- *Congenital or acquired nystagmus*, which we will discuss in section 2 E 3, is due to a difficulty in maintaining the position of the gaze, induced by cerebellar or vestibular neurological causes.

Figure 5: *Processing the information:*



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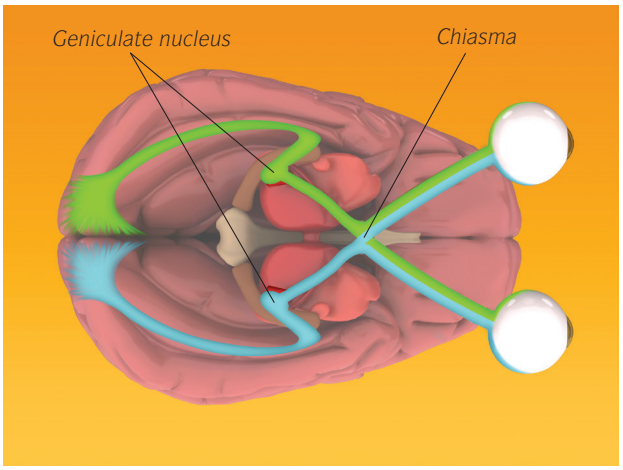
a) Cross-sectional view of the retina.



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b) Visual pathway: the left temporal and right nasal retinas are projected in the left cortex and the right temporal and left nasal retina in the right cortex.

B Explorative techniques of ocular diseases

Visually impaired people seeking rehabilitation often provide their medical file. This provides access to a precise diagnosis of their condition, as well as the images taken in order to obtain the diagnosis and monitor changes in the lesions and the effects of any treatment. To help in the reading and understanding of these images, we present below the principal examinations carried out in this respect, which complement the preliminary clinical observation made by the Eye Specialist.

1. Retinal Photography

This examination consists in taking photographs of the back of the eye under various conditions and at given times. The plates obtained assist with diagnosis as well as with the objective monitoring of the evolution of the diseases.
The examination starts with a photograph giving a baseline picture of the fundus, as observed by the Eye Specialist during the consultation (figure 6 a). Then, during the different visits, plates can be made made using green (or red-free), red, blue and auto-fluorescing light, by interposing filters of differing wavelengths in front of the lens.

- The green-light plate provides the best analysis of the vascular structures of the back of the eye and therefore shows any haemorrhages.
- The red-light plate, by reducing the contrast between the vessels and the back of the eye, provides a better analysis of the epithelial structures and makes pigmentations more visible.
- The blue-light plate is highly dependent on the clarity of the media. On the other hand, it provides a view of the xanthophyll pigment and therefore a detailed analysis of the macular zone and also any deficiencies in the optic disc's optical fibre layer.
- The auto-fluorescing plate highlights the normal auto-fluorescing structures at the back of the eye. By showing any auto-fluorescence anomaly, it allows a precise delimitation of the atrophic structures, in cases of AMD, for example.

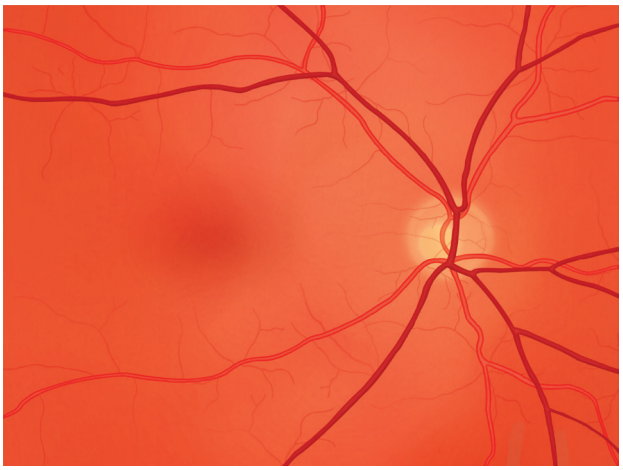
This examination is usually carried out with or without slight pupillary dilation but, if the Eye Specialist wishes to explore a peripheral part of the retina, as in the case of a risk of diabetic retinopathy for example, the degree of dilation needs to be greater. An OCT or angiography is also usually carried out.

2. Retinal Fluoro-Angiography

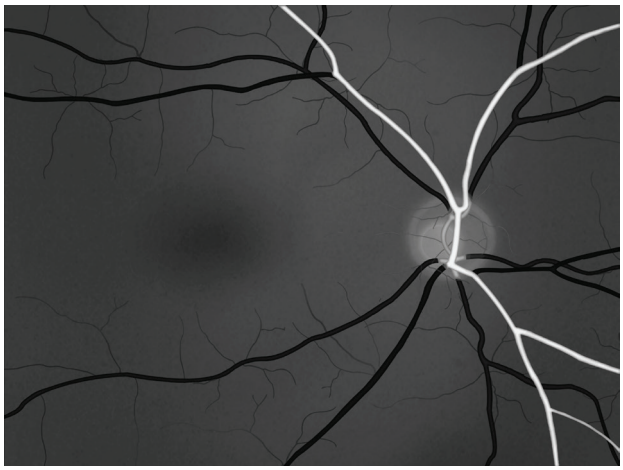
Fluoro-angiography is an examination that explores the quality of the vessels, with the purpose of detecting any lesions. Retinal angiography is used to view the vascularisation of the retina and the choroid. A fluorescent contrast product is injected into the circulatory system in the fold of the elbow. The colourant is transported in the blood flow through the network of arteries and then veins in the retina and progressively colours all the vascular structures on the back of the eye before gradually disappearing.
By repeatedly photographing the fundus every second after the injection, with the pupil fully dilated, a series of photographs are obtained that allow anomalies to be interpreted in line with variations in the propagation of the fluorescence as it gradually appears. This examination lasts twenty minutes on average, but requires prior dilation of the pupils.

Figure 6 b shows an angiography in the early stages: only the main arteries are fluorescent (shown in white on the plate). Little by little, the fluorescence invades the vascular system in c), then d), known as the latter stage. On the different plates, the vessels are very clear and precise, the back of the eye is clear of anomalies and there is no lesion.

Figure 6: *Photographs showing the fundus of a normal eye:*



a) Photograph of the fundus (retinography).



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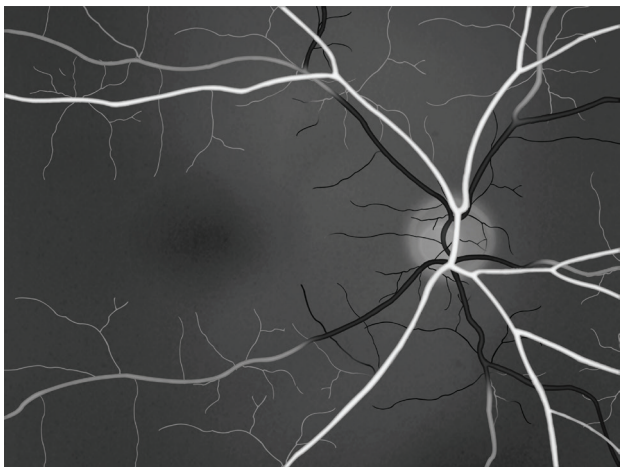
b) Early stage angiography: only the main arteries show as fluorescent (in white).



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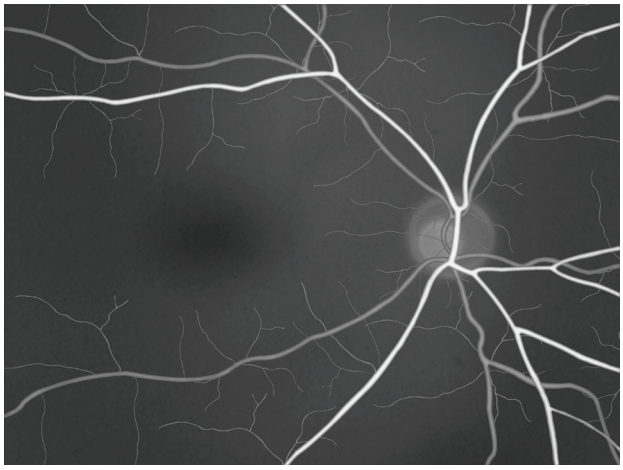
c) All arteries appear fluorescent.



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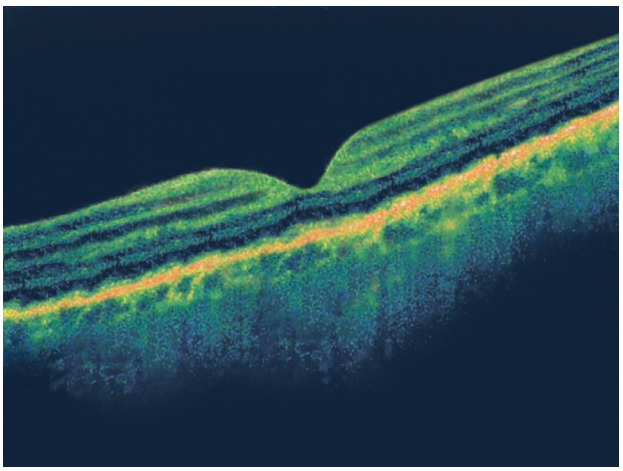
d) The veins are now coloured.

3. Optical Coherence Tomography: OCT

Optical coherence tomography is an exploratory, diagnostic and therapeutic monitoring technique for diseases of the retina. It is an examination that produces a very precise cross-section of the retina, so that its different layers can be analysed and any lesions present in the deep layers that cannot be seen when simply looking at the back of the eye can be viewed. This recent and innovative technique uses infra-red light, the photons of which pass through the structures of the retina and are reflected on each of its layers, which can then be represented very accurately. It is a quick examination, simple and non-invasive, and does not require extensive dilation of the pupil or present any tolerance problem in patients. The quality of the images thus obtained provides an accuracy very close to that of histology. Figure 7 shows a section of a healthy retina around the macula, taken by OCT. The organisation of the main layers of the retina (photoreceptors, ganglion cells, external limiting membrane etc.) can be observed. It does help to understand the characteristics of some typical clinical images of retinal pathologies leading to impaired vision, which are described in the next chapter.

This method is also used to assess the thickness of the nerve fibre layer in the head of the optic nerve, when monitoring glaucoma, for example. The results are analysed by the Eye Specialist and correlated with those from other measurements, such as intra-ocular pressure, the field of vision etc.

Figure 7: *OCT of a normal eye:*



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OCT plate of a normal eye: the different cellular layers of the retina can be observed.

4. Visual Fields

Knowing that all the projections of the visual pathway, from the retina to the visual cortex, are retinotopic (i.e. that they are projected in the visual field in an exact mapping), recording the visual field allows the study of the visual pathway and also helps to find the location of any ocular or cerebral lesions.

The visual field is the extent of the perceptible space in which the eye, looking straight ahead, perceives light, form and colours, without the patient moving either their head or their eyes. In the healthy adult, it extends up to 180° in the horizontal axis and extends 120° in the vertical axis. The blind spot is situated in the temporal zone of the normal field of vision; it is an absolute scotoma, a zone in which there is no perception at all. This non-functional region of the visual system, which corresponds to the optic disc, i.e. the point of confluence and exit of the retinal nerve fibre layer, is off-centre by 12 to 18 degrees from the centre of the macula and extends for approximately 10°.

The examination of the visual field consists in assessing the perception of spots of light of greater or lesser intensity in the visual field for a given eye. It is carried out in a darkened room with only the inside of the perimeter illuminated. The patient places their chin on a rest and is instructed to keep fixating on a point straight in front of him.

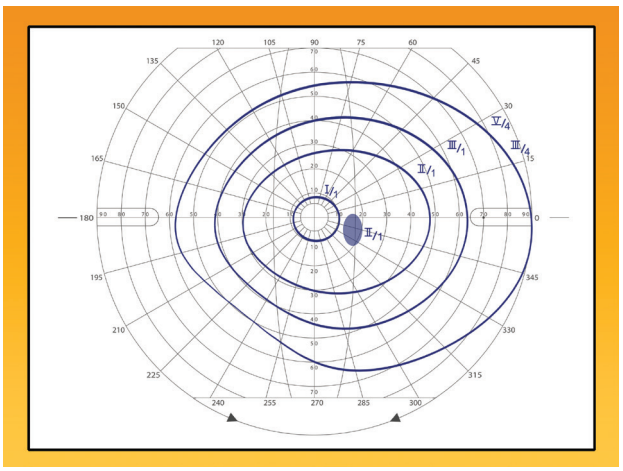
These recordings may be made:

- Using a *Goldmann perimeter* which allows a kinetic map to be made of the space perceived by an eye when immobile. With this apparatus, it is also possible to highlight the visual field by making a binocular examination.

  Figure 8 shows a *Goldmann perimeter* and the reading made with this examination. 8 a) Shows a patient seated comfortably, equipped with a push-button which he/she activates on seeing the dot of light. An operator moves the dot, in the zones of the field that he/she wishes to explore. Figure 8 b), shows the plot of the visual field in a normal patient. Each isopter corresponds to increasingly reduced brightness and sizes of the dot. Isopter V/4 is obtained with a spot whose surface is the largest and the light intensity the strongest; isopter I/I with the smallest, least bright dot.

Figure 8: *Normal visual field with the Goldmann perimeter (kinetic perimetry):*

a) Goldmann perimeter.



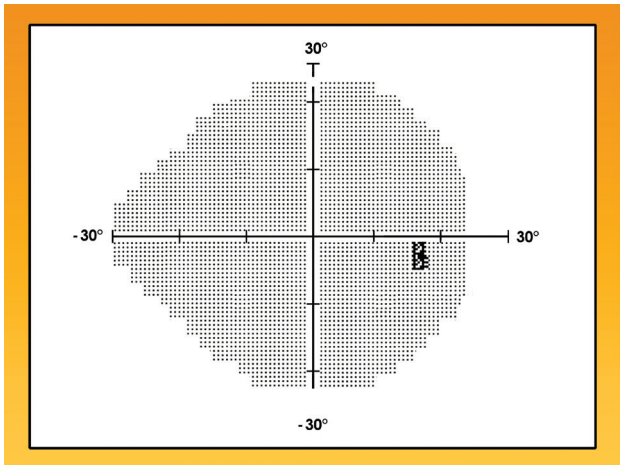
b) Plot of the normal visual field of a right eye.

- *With an automatic perimeter that* gives a detailed static mapping of the central sensitivity of the retina up to 30° of eccentricity.

  Figure 9 a) shows an automatic perimeter with the patient seated in front of it, equipped, as previously, with a button that they press when they see the spots that appear randomly in their central field of vision. Figure 9 b) shows the map of the trace obtained using this method.

Figure 9: *Normal visual field with the automatic perimeter (static perimetry):*

a) Automatic perimeter.



b) Plot of the normal visual field of a right eye.

The practitioner chooses the type of visual field examination, according to the anomaly being investigated.
These two examinations are interpreted according to losses of sensitivity or area of constriction or losses in the field of vision. Some anomalies, suggesting damages to the visual pathway, need to be investigated through a neurological examination.

C Loss of Central Vision

The central vision, inextricably linked to the properties of the macula, may be assessed clinically by the following examinations:

- *At a sensory level:* by the measurement of the visual acuity, contrast sensitivity, colour vision and sensitivity to high spatial frequencies.
- *On a motor level:* by the assessment of the ability to keep both eyes fixed on an object at any distance and in all directions of the gaze; it is assessed by the quality of the ocular fixation, smooth pursuits, saccades and vergences.
- *On a functional level:* by the assessment of fine discrimination, of visual detail, of the localization of objects in relation to oneself and in space, therefore, the precision of eye-hand coordination.

1. Impairment and Functional Consequences

Impairments due to diseases affecting central vision disrupt these various functions and create difficulties which the patient notices and reports, with regard to reading, recognising colours, manual tasks requiring fine discrimination, recognising faces passed in the street etc... Also people affected by central vision impairment complain of a lack of light while being highly photophobic, perceiving a "blur", loss in field or even metamorphopsia (distortions) in the central part of their field of vision.

Some patients may talk about visual hallucinations; this is called Charles Bonnet's syndrome. This phenomenon is linked to a visual sensory deprivation in the event of loss of central vision and occurs in people suffering from visual impairment, where there is no mental disturbance. These patients are perfectly aware of the non existence of what they perceive. Interference images are structured, in colour and represent plants, objects, geometrical shapes, people, animals etc. Their appearance varies from a few seconds to a few minutes and may recur during a single day or over several days.
There is no really effective treatment using medication; total or partial disappearance is most often linked to an improvement in the structure or functional vision and a behavioural strategy which aims to reassure the patient of the common nature of this syndrome and especially the absence of cognitive or psychiatric degeneration.

2. The Principal Conditions Resulting in the Impairment of Central Vision.

The most frequent pathologies are:

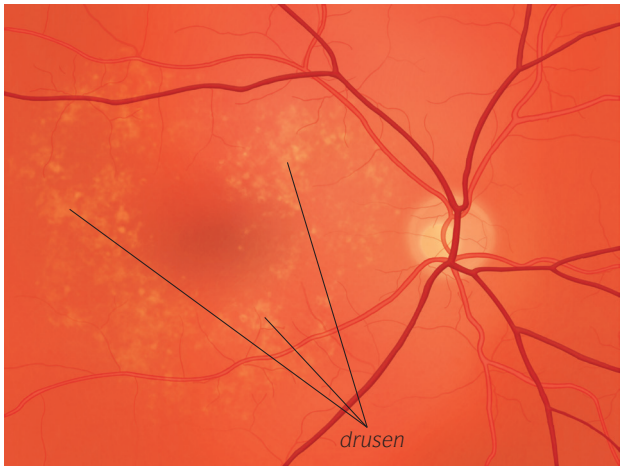
a) Age-related Macular Degeneration (or AMD)

This is the primary cause of visual impairment in western countries; it affects one person in four after the age of 75 and almost half of patients after the age of 90 years. It is a multi-factorial condition of genetic origin, to which are added environmental or behavioural factors such as excessively refined diet, tobacco, repeated exposure to light, etc.
Depending on the form of AMD, we find the following anatomical lesions: reduction in the number of rods in the macular area, degeneration of the cones, damage to the retinal pigment epithelium or choroidal neo-vascularisation.

One usually distinguish between two types of AMD:

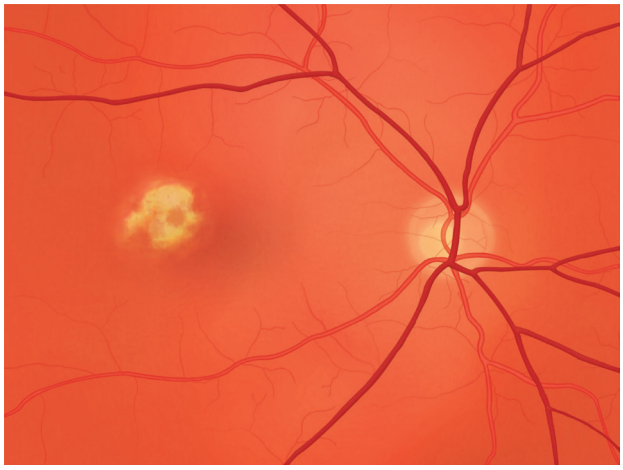
- The atrophic form (known as "dry"):
This is characterised by areas of atrophy where the pigment epithelium and photo-receptors have disappeared. Development is slow and often respects the fovea for a long time. In the initial stages, whitish deposits, called Drusen, appear (figure 10 a). These are waste, resulting from transduction, which the retina has not managed to eliminate. In parallel, photo-receptor cells and the retinal pigment epithelium disappear, leaving scarred areas that slowly extend as the disease develops over a number of years, without the patient being aware of visual impairment. These plaques finish by joining up and reaching the centre of the retina, thus causing a progressive reduction of vision. Figure 10 b) shows the atrophic area on the macula of a person already well aware of a loss of acuity of central vision; figure 10 c) shows its perception in daily life.
Current medical care consists essentially of taking food supplements such as vitamins C and E, zinc, lutein, xanthophyll, beta-carotene etc. Use of filter lenses and rehabilitation of the residual vision need to occur as quickly as possible.

Figure 10: *Atrophic AMD:*



© Essilor International

a) Drusen.



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b) Atrophic macular area.

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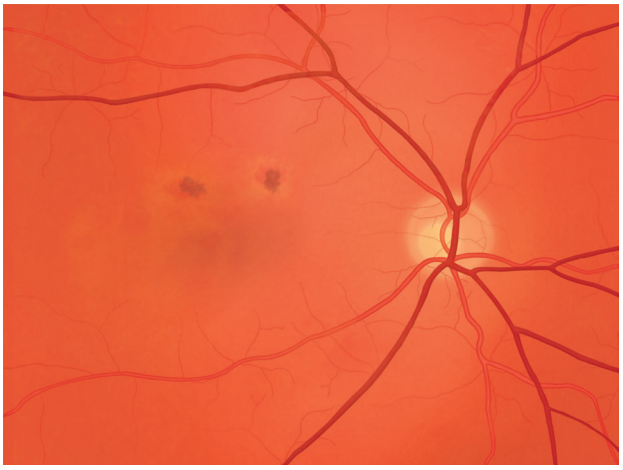
c) Perception by the patient: central scotoma.

- The exudative form (known as "wet"):
This is characterised by the development under the retinal pigment epithelium of a neo-vascularisation coming from the choroidal vascular system. Development is rapid and often severe. By forming under the retina, on the macula, these abnormal vessels cause retinal creases which create metamorphopsia and result in a sudden reduction in vision. Figure 11 a) shows the condition of the fundus of people suffering from exudative AMD. The neo-vessels can be seen there and also little haemorrhages due to the poor quality of these neo-vessels which leak or break easily; figure 11 b) illustrates a representation of what the patient perceives in their daily life.
The current medical treatment is intra-vitreal injection of anti-VEGF (Vascular Endothelial Growth Factor) repeated according to effectiveness on the neo-vascularisation. This anti-VEGF is a product which limits the proliferation of the neo-vessels and at the same time provides control of the development of the exudative AMD. The rehabilitation is adjusted according to the variation in the vision.

Figure 11: *Exudative AMD:*



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a) Appearance of fundus of a person suffering from exudative AMD.

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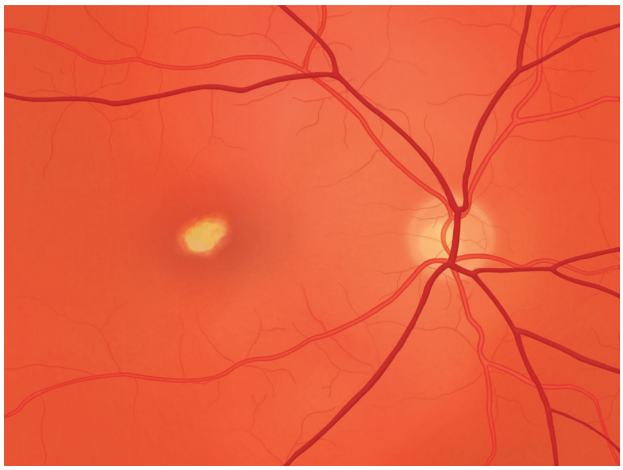
b) Perception by the patient: metamorphopsia.

b) Stargardt's Disease

Often called hereditary macular degeneration, this is a bilateral, almost symmetrical macular disorder of genetic origin. It usually starts at between 7 and 15 years of age and stabilises at around 20. It affects approximately one in twenty thousand children by disturbing their colour vision and progressively reduces visual acuity (down to 20/400 or 3/60) while preserving peripheral vision. The visual field test shows a central scotoma.

Figure 12: *Stargardt's disease:*



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a) Appearance of the fundus of a person with Stargardt's disease.

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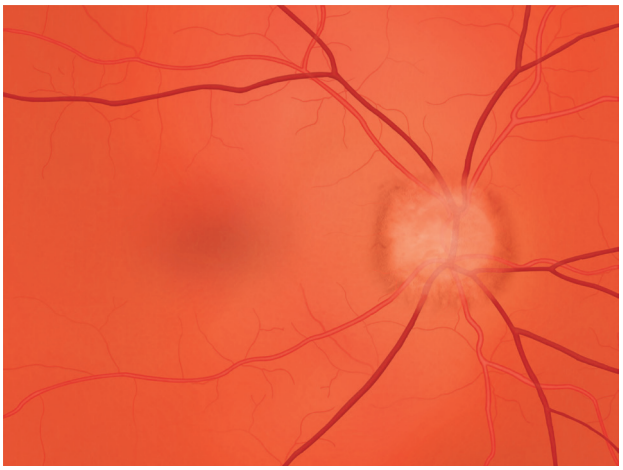
b) Perception by the patient: central scotoma.

c) Leber's Hereditary Optic Neuropathy (LHON)

This is a monocular disorder of genetic origin, which rapidly becomes bilateral. It starts at between 15 and 35 years of age with a sudden loss of visual acuity in one eye and then the other; colour vision is disrupted. Observation of the fundus reveals a swollen optic disc before the stage of optic atrophy. This condition is actually a hereditary atrophy of the fibres of the optic nerve. The visual field test shows a central scotoma.

Figure 13: *Leber's Hereditary Optic Neuropathy:*



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a) Appearance of the fundus of a person with LHON: swollen optic disc.

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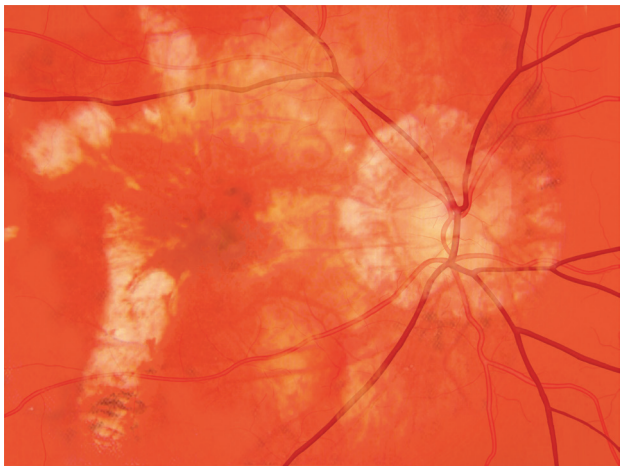
b) Perception by the patient: central scotoma.

d) High Myopia and Myopic Degeneration

This myopia is of an axial origin: the ocular globe is "too long" and causes stretching of the tissue as it grows. Thus, the choroid and retina are stretched and can then become detached and tear, causing a macular hole or peripheral tears. They are most often accompanied by complications such as an early cataract, atrophic degeneration of the macula, called Fuchs' spot, choroidal atrophy or even haemorrhages caused by the appearance of choroidal neo-vessels. These phenomena can be encountered in eyes with six to eight dioptres of myopia and more.

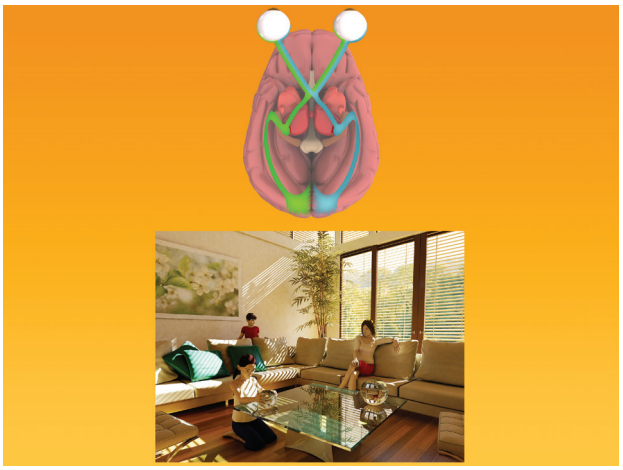
Figure 14: *Degenerative myopia: atrophic retina:*



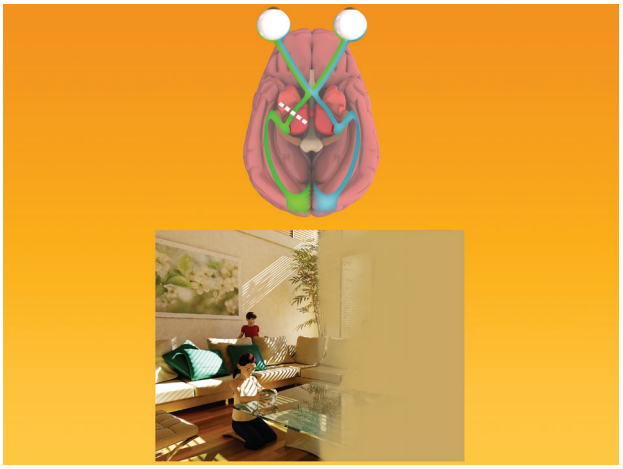
e) Optic Neuropathies and Damage to the Visual Pathway

These are conditions of the optic nerve, whose origins may be toxic (tobacco, alcohol, medicaments, hazardous materials at the workplace, etc.), inflammatory (e.g. multiple sclerosis), vascular (e.g. arteriosclerosis), compressive (e.g. tumours) etc. The often sudden loss of visual acuity may be accompanied by pain when moving the eyes and by headaches. Some of these conditions may regress when the toxic products are discontinued and the cause removed. These conditions cause a central scotoma but, in certain cases, according to the location of the disorder (stroke, tumours etc.), they may also create peripheral impairment.

Figure 15: *Optic neuropathies (peripheral loss):*



a) Normal perception.



b) Hemianopsia due to a lesion on the optic nerve occurring after the optic chiasma.

c) The optic nerve of the right eye is not transmitting the visual inflow; only the left eye sees.

D Loss of Peripheral Vision

The peripheral vision has various functions in the vision:

- *At a sensory level:* the peripheral retina analyses the perception of shapes, contours and silhouettes but also spatial orientation and movements.
- *At a motor level:* it is behind the triggering of the saccades and participates in the fluidity and stability of vergence movements.
- *At a functional level:* it allows long words to be read, a line to be followed and the phenomena of anticipation. It perceives surrounding space in its entirety, therefore assists with mobility and movements in space, such as, for example, movement of the arm when making a grasping movement.

1. Impairment and Functional Consequences

People affected by the disruption of peripheral vision, describe significant difficulties associated with variations in brightness in their environment: they are greatly "blinded" by excess light in sunlight and conversely "almost blinded" by the lack of light when night falls. Most people affected indicate a reduction in the field of vision and therefore have to move their eyes and head to perceive a visual scene in its entirety, whether when reading, to see the end of the line or read long words, or to find their way in the street... They can only take in a restricted field of vision. Others describe "shortcomings" in their vision and can only read with great difficulty and for a short time only.
These people frequently bump into things or easily get a fright, as thing coming from their side suddenly appear right in front of them without any warning. They cannot anticipate movements and describe loss of balance when walking.
A description of such symptoms directs the investigation towards a condition affecting peripheral vision.

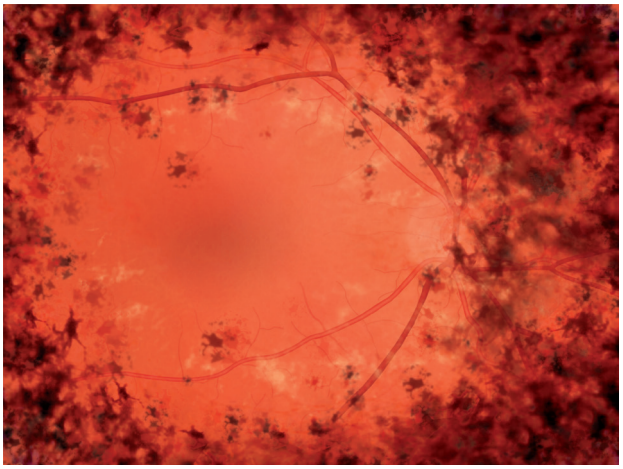
2. Common Conditions Resulting in Peripheral Vision Loss.

a) Retinitis Pigmentosa

Retinitis pigmentosa affects approximately one person in five thousand in developed countries. This is a disease with multiple genetic origins which cause important changes to the retina. Today, more than 100 genes, responsible for this condition, have been isolated, and this explains why the forms of retinitis pigmentosa encountered can be diverse and various. Overall, we can say that it is the rods that are disrupted first, then the cones, and this gradually leads to blindness. These diseases evolve slowly: it is the perceived level of brightness that is decreased first. The field of vision shrinks regularly and progressively, often in a concentric way until it becomes a "tunnel"; the visual acuity remains good initially but then declines and the colour vision is affected to the point of achromatopsia in the final stages. Complications are frequent; cataracts, detachment of the vitreous are common secondary effects. During examination of the fundus, quite typical deposits of pigments called bone spicules are observed. These are illustrated in figure 16 a).

Retinitis pigmentosa starts most often between 18 and 30 years of age with accelerated decline between 40 and 50. It may be associated with other diseases; the most common is Usher's syndrome which combines sight loss with profound hearing difficulties.

Figure 16: *Retinitis pigmentosa:*



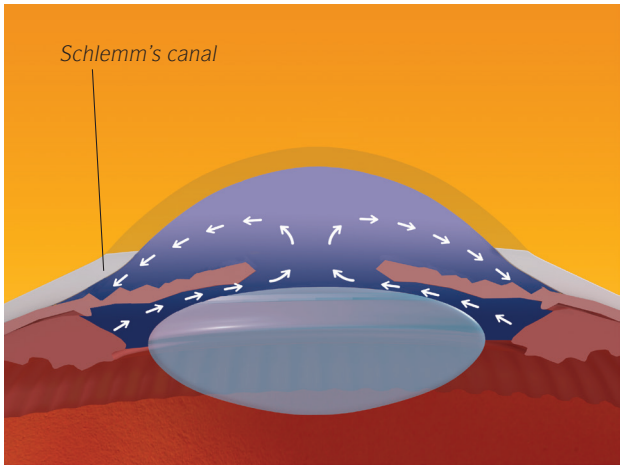
a) Appearance of the fundus of a patient affected by retinitis pigmentosa, deposits of pigments called bone spicules.

b) Perception by the patient: tunnel vision.

b) Glaucoma

In developed countries, this disease affects 1% to 2% of the population between 40 and 50 and 4% after the age 80. It manifests itself in various forms, depending on the cause (open or closed angle glaucoma) or its presentation (chronic or acute glaucoma) but, whatever the form, it is a degenerative disease of the optic nerve, worsening with the increase in intra-ocular pressure (IOP). The change in IOP is dependent on the secretion of aqueous humour by the ciliary body and the ease of flow through Schlemm's canal located in the iridocorneal angle (figure 17 a). It is a disease which causes blindness and which is usually not painful. When left untreated, the intra-ocular pressure has a detrimental effect on the head of optic nerve, whose fibres become atrophic. The glaucoma results in a loss of contrast sensitivity first and then in a reduction in the visual field and a loss of visual acuity potentially leading to blindness. Figure 17 b) shows the perception of a patient with advanced glaucoma. This perception varies according to the stage of the condition. The loss of vision is permanent.
Eyedrops are the treatment most often prescribed. Their use is often effective but drops must be administered daily and often for life. If it is ineffective, a surgical operation may be undertaken. It is a completely benign operation which consists of cutting the trabeculum with a laser to facilitate the movement of aqueous humour towards the canal of Schlemm, in order to normalise the intra-ocular pressure.

Figure 17: *Glaucoma:*



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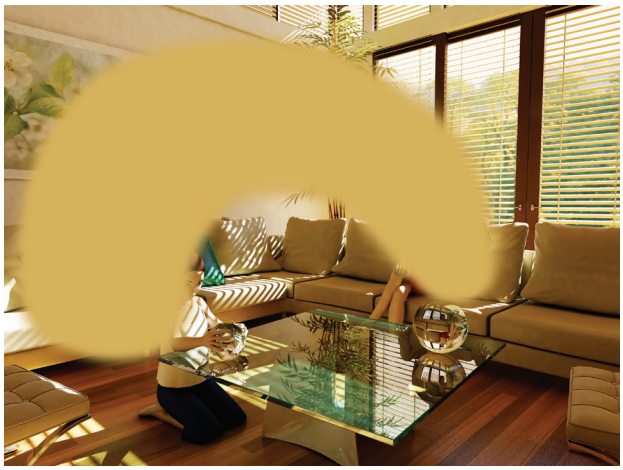
a) Flow of aqueous humour in the eye: the evacuation occurs via the canal of Schlemm located in the iridocorneal angle.



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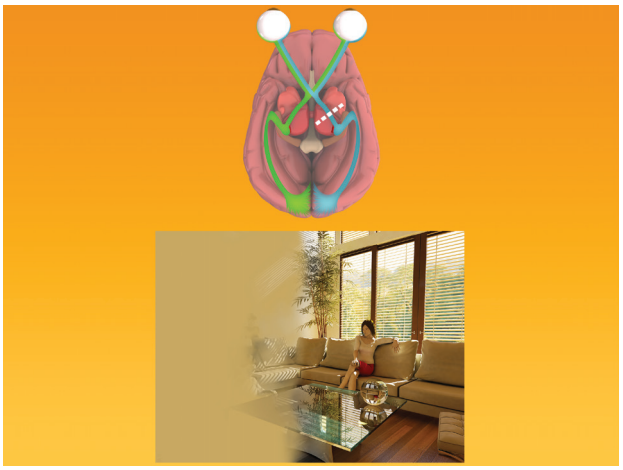
b) Perception of a patient with glaucoma.

c) Lesions of the Visual Pathway

These lesions on the optic or cerebral nerve(s) lead to damage in visual pathway. Their origins may be inflammatory (e.g. multiple sclerosis), vascular (e.g. arteriosclerosis), compressive (e.g. tumours) etc. They are the cause of highly variable losses in the fields of vision and require an urgent ophthalmologic investigation. Post chiasmatic lesions usually show similar loss of field in both eyes. Because of the structure of the vascular tree in the posterior part of the brain, the visual cortex can suffer a loss of blood supply (a stroke) on one side only and the result will be frequently a bilateral loss of half the visual field (e.g. a bilateral hemianopsia. Figure 18 b) shows the perception of a person suffering from a bilateral homonymous hemianopsia.

Figure 18: *Lesions of the visual pathway:*



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a) Lesions of the visual pathway from the optic chiasma to the right visual cortex.

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b) Perception of a person with hemianopsia (left hemianopic scotoma).

E General Loss of Vision

Some conditions can affect either the central retina or the peripheral retina or both at the same time, and this is the case with diabetic retinopathy, for example.

1. Diabetic Retinopathy

Diabetic retinopathy is one of the consequences of both type-1 and type-2 diabetes and is greatly feared as a complication. It is the most frequent cause of blindness in adults under 50. It manifests itself as lesions on the retinal capillaries and thus causes retinal haemorrhages and macular oedema or ischaemia.

Different stages of its evolution are usually described. We only mention those whose differences in terms of functional impact are useful in determining how to treat the visually impaired person.

Impairment and Functional Consequences of Diabetic Retinopathy

- *An initial retinopathy* does not cause any functional signs but regular ophthalmic monitoring is strongly recommended.
- *A more established retinopathy* can cause a reduction in visual acuity with a macular oedema affecting the central vision. At that stage, people mostly express their difficulty with near vision, with a permanent blurry sensation, making reading tiring and complicating filling in official forms, for example. In intermediate vision, some activities requiring precise vision, like shaving, cutting one's nails, peeling vegetables, sewing on a button etc., become difficult.
- *An advanced stage* of diabetic retinopathy causes a significant reduction in visual acuity and loss of visual field through scattered scotomas, due to retinal haemorrhages, that cause patchy vision, as shown in figure 19 b). In such cases, patients experience often serious disabilities.

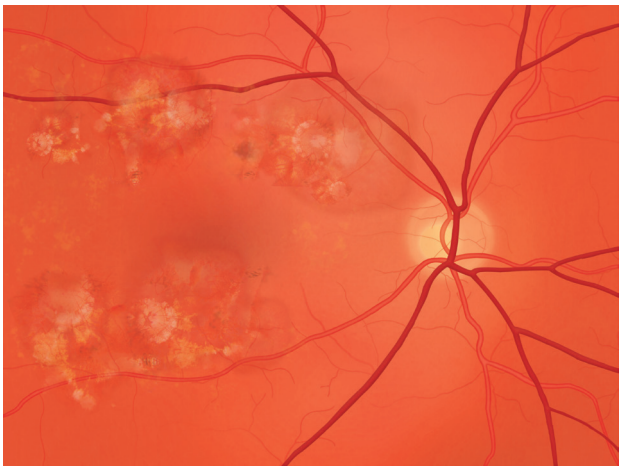
2. Cataracts

Cataracts are the number-one cause of visual impairment in the world. This condition, due to the opacification of the crystalline lens can usually be improved by extraction and replacement by an intra-ocular implant. In younger patients, it may be associated with other ocular conditions such as retinitis pigmentosa, glaucoma, high myopia etc… In these cases, extraction of the crystalline lens can aggravate the coexisting condition and risk causing macular remodelling or present serious risks of retinal detachment, as in high myopia. This is why this surgery is sometimes postponed.

3. Congenital and Acquired Nystagmus

A nystagmus is a jerky involuntary movement of the eyes. The clinical sign may be present from birth – this is called congenital nystagmus – associated or not with strabismus or with more serious ocular conditions such as albinism or congenital cataracts, which are sources of visual impairment. They may also appear later in life – this is called acquired nystagmus – most often the result of a neurological disorder or a tumour. The treatment is that of the cause, when it is identified.

Figure 19: *Diabetic retinopathy:*



a) Appearance of the fundus in a patient suffering from advanced diabetic retinopathy.

b) Patient's perception: scattered scotomas.

3. Low Vision Aids

Low vision aids allow people with sight loss to see details that they can no longer perceive with their residual capacities, enabling them to carry out specific tasks that had become impossible. No vision aid can give back vision in all conditions; each one is determined according to a particular task to be accomplished, the specific circumstances of the person and their visual status.
This chapter describes the various families of Low Vision Aids that can be offered to people with sight loss and details their practical applications.

A Lighting

Retinal sensitivity diminishes with age and lighting must be adapted accordingly. Conditions affecting the sight and subsequent visual impairment create a reduction in functional vision, often associated with an increased sensitivity to light and photophobia. Lighting conditions play a critical role in the visual perception of visually impaired people. It is essential to optimise level of light in the surroundings, wherever possible, in order to make the residual functional vision as efficient as possible.
To obtain maximum effectiveness and comfort, it is essential to advise the person in their choice of lighting equipment, its installation, its arrangement and its orientation, according to the desired use.

Attention must be paid to the following points:

- Avoid all sources of glare: organise blinds and curtains to mitigate variations in natural lighting.
- Try to make ambient lighting as uniform as possible across the various spaces the person navigates, in order to avoid areas of shade.
- Provide specific lighting in work areas using desk lamps with lighting directed towards the task to be completed, and in such a way that it does not cause glare.
- Choose the colour and intensity of the light source necessary for the visually impaired person to achieve visual effectiveness, according to both their tastes and their visual needs.

Figure 20: *A suitably equipped work-station. The lighting is directed towards the sheet positioned to the left of the patient, so that there is no shade falling on the work surface.*

Light characterisation: a few definitions

A light source can be characterised by its *Power* expressed in watt (W). *The Luminous Flux* it emits is measured in lumen (lm) and characterises the amount of light according to the eye's sensitivity. *The Luminous Intensity* measures the importance of the luminous flux emitted by the source in a given direction in a given solid angle; the international unit is the candela (1 cd = 1 lumen / steradian).

When the source illuminates a surface, the *Illuminance* is defined by the luminous flux per surface unit. It is expressed in lux (1 lx = 1 lm / m^2). It can be measured with a lux meter; this instrument is useful in low vision practice.

The *Luminance* describes the light flux emitted or reflected by a surface unit in a given direction. It is given in candela per square-meter (cd / m^2). This Luminance is the one perceived by an observer's eye.

The *Colour Temperature* of a light source is the temperature at which a black body should be heated to produce the same light emission; it is expressed in kelvin degrees (K). The more intense the light and the more white, the higher the colour temperature: about 2700 K for a yellow light, 4500 K for a white light and 7000 K for a bluish light.

The *Spectral Distribution* of a light source is the distribution of the monochromatic radiations emitted by the source.

Various types of lamps

- The *Filament Lamps* include a tungsten filament placed in a neutral gas and heated until glowing incandescent under the effect of an electrical power. They emit a "warm" light (with a dominance of red). They have a limited lifespan and are less and less in use. The *Halogen Lamps* use a halogenated neutral gas introduced in heat resistant crystal quartz bulbs. They have a higher luminous efficacity and a longer lifespan than the traditional filament lamps.

- *The Fluorescent Lamps* emit light under the effect of an electric discharge stimulating a fluorescent layer deposited inside a tube. They emit more blue light than the filament lamps. The *Compact Fluorescent Lamps* are a reduction in size of the fluorescent tubes. They are available in a wide range of colour temperatures. With their lower energy consumption, they progressively replace filament lamps.

- The *LED Lamps (for "Light Emitting Diode")* include opto-electronic components producing light when stimulated by an electric power. They emit a "cold' light (with a dominant of blue). Energy saving and originally designed for electronics, they are more and more used for lighting.

B Filter Lenses

When the visually impaired person can no longer arrange their environment to achieve the best possible visual comfort, specific filtering lenses may be used to alleviate the consequences of inappropriate ambient lighting conditions.

1. Chromatic Filters

Filters have the particular feature of transmitting selectively specific wavelengths in the light spectrum. The main purpose of the special filters used in low vision is to absorb, and thus eliminate, all the ultra-violet light and to some extent the blue light. This is why they appear yellow to orange, even brown/red. These filters promote an improvement in the visual function by optimising the perception of contrast and limiting glare.
All these colours may be produced on afocal lenses but can also be applied to corrective single vision, multifocal and varifocal lenses, in order to produce comfortable, customised lenses. Manufacturers offer a wide range of clip-on filters, fit-over glasses and frames with wide arms or lateral screens to eliminate unwanted light and in which specific corrective lenses may or may not be fitted. While improving the wearer's visual comfort, these lenses unavoidably disrupt the perception of colour, and this can cause difficulty or discomfort for certain activities.

Figure 21: *Specific examples of chromatic filters.*

Blue Light
Blue light is the most energetic part of the visible spectrum, which extends from 380 nm to 780 nm. Also known as "HEV" (High-Energy Visible), it covers the spectral area from 380 nm to 500 nm, from the violets (380 nm to 420 nm) to the blues (420 nm to 500 nm). High in energy, it is more scattered in the atmosphere than other wavelengths in the visible spectrum. Blue light is present in direct sunlight but it is also emitted by numerous artificial light sources.
Since the blue light penetrates the eye, it has an effect on vision and on the retina:
- Effect on vision: due to its greater scattering by transparent media, it is an important factor in glare; also, through its focusing in front of the retina by the eye's optical system, it is the cause of a loss of sharpness. Visually impaired people are particularly sensitive to this.
- Effect on the retina: in the same way as with ultraviolet radiation, blue light participates in the degeneration of retinal cells (retinal pigment epithelium and photoreceptors): repeated and/or prolonged exposure to blue light can cause photo-traumatism of the retina; in the long term, the cumulative effects of exposure to blue light are considered a factor accelerating the ageing of the retina and a risk factor in AMD.

2. Polarising Filters

Polarising lenses provide wearers with a reduction in glare and improved perception of colours and depth. Under normal conditions, these two benefits are brought about by the elimination of horizontally reflected light. This reflected light is superimposed on the light coming from the object being looked at and increases the amount of light entering the eye. In the case of the visually impaired person, it is important to eliminate this light. Polarising filters are particularly valued by these patients.

As with chromatic filters, polarising filters, tinted by definition, may be combined with any type of single vision, multifocal or varifocal lenses and also with certain specific chromatic filters.

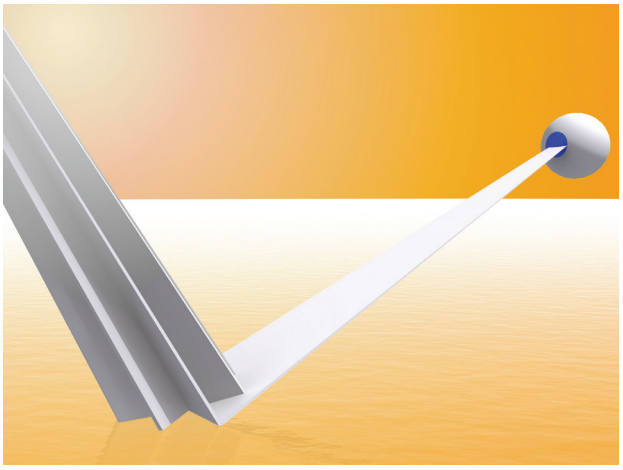
The Principle of Polarisation
Light is an electromagnetic vibration that oscillates in all the collinear planes having the light's line of propagation as their sole line of intersection. When it is reflected by a flat surface, light becomes partly polarised, i.e. part of the light (incident at the Brewster angle) vibrates only in a single plane, the plane perpendicular to the plane of incidence (which is defined by the direction of the light ray and the normal to the plane of the reflecting surface). For example, when light from the sun is reflected by a horizontal surface, like the ground or a lake, it only vibrates in the plane perpendicular to the vertical plane passing through the point of incidence and including the direction of the reflected light; in this plane, the light's axis of the vibration is horizontal. If a vertical-axis polarising filter is interposed between this light and the eye, so having a polarising direction perpendicular to the vibration plane of the reflected light, it is possible to completely eliminate this light. This is the functioning principle of polarising lenses.

3. General Principles for Choosing Filter Lenses

A number of filters can be produced by surface-treating plastic lenses in CR39 or other materials, whether they are afocal or corrective. They are effective in numerous applications for visually impaired patients. These lenses provide protection against ultraviolet rays, improve the perception of contrast and visual acuity and provide better visual comfort. Unfortunately, there is no single, all-encompassing relationship between the visual complaint, the transmission/absorption characteristics of the filter and the comfort it can provide. Only a trial by the patient under actual conditions of use and by means of additional faces or enveloping fit-over glasses (figure 21), allows determination of the tint and the intensity of the most effective filter. Having said that, a few general principles may be offered to assist in the choice of the most appropriate filtering lens:

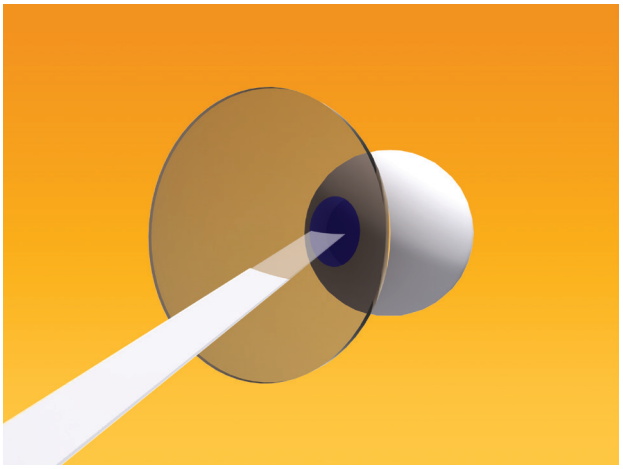
- In the first place, the choice of a filtering lens always results from joint work by the patient and the practitioner. Most often, it is actually the patient who chooses the filter according to recommendations made and from a pre-selection of filters offered.

Figure 22: *Operating principle of a polarising filter:*



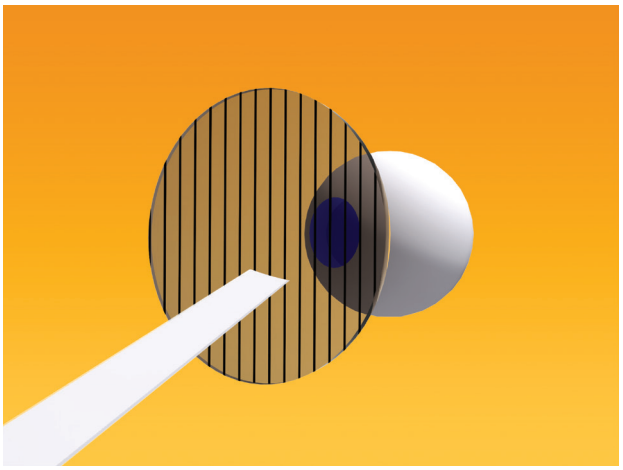
© Essilor International

a) The principle.



© Essilor International

b) Polarisation of the light reflected.



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c) Total elimination of the light by a polarising filter.

- A filtering lens operates according to two main characteristics: its spectral selectivity, which influences the visual perception, and its intensity, which influences the protection against glare. This is why we make the choice of filter tint first, to improve a patient's vision before making the choice of filter intensity for the protection from the light.

- In practice, we initially use an "objective" method, measuring visual acuity and/or sensitivity to contrast to measure the effectiveness of the filter in improving visual acuity or perception of contrast, on the one hand, and overall visual comfort on the other. This assessment is made by successive comparisons progressing from the lightest to the darkest filters, with increasing amounts of UV cut out: 400 nm, 450 nm, 500 nm, 511 nm, 527 nm etc. ... This assessment may also be made using special software that allows the perceived gain in contrast to be measured for different filters.

- Subsequently, a "subjective" method is used for the assessment of filters by the patient themselves: it consists of getting them to try filter lenses in situations of actual use and, more particularly, in the situation of a visual task to be carried out, and in an outdoor environment.

- Visually impaired patients often need several filter lenses to make up their ideal equipment: one filter for indoors and one or more filters for outdoor use, depending on the lighting conditions or the tasks to be completed. To determine the necessary filters, we always start by determining the optimum filter – tint and intensity – for indoor use. Then, for outdoors, we start off with a filter with an identical tint but with a higher density.

- The choice of a filter is at times a compromise between visual comfort and quality of vision, a compromise between protection and perception. Too intense a filter risks causing a reduction in the patient's vision, too light a filter risks not providing the required visual comfort. To choose the best compromise, it is necessary for the practitioner to be able to assess which is most important for the patient, protection or perception.

Filters are simple and effective solutions for improving the vision and comfort of visually impaired patients. Their use can only grow with the increase in visual impairment among the senior population.

C Magnifiers

To enable the visually impaired person to perceive details and be able once more to accomplish certain tasks, such as reading, we call upon vision aids that magnify, the most simple of which are magnifiers. We should recall here their optical principle and the way they are used.

1. Description

Magnifiers are the simplest and easiest systems to use to magnify objects: texts, telephone numbers, prices in shops, etc. They comprise one strongly convergent lens or a combination of convergent lenses positioned face to face, in order to reduce spherical and chromatic aberrations. These magnifying aids have the particular feature of producing an erect, virtual, magnified image.

2. Principle

This optical system, composed of one or two converging lenses, only forms an erect magnified image if the object is placed inside the first principal focal plane of the lens.

When an eye looks through a magnifier, it perceives the virtual optical image that the magnifier forms of the object being viewed.

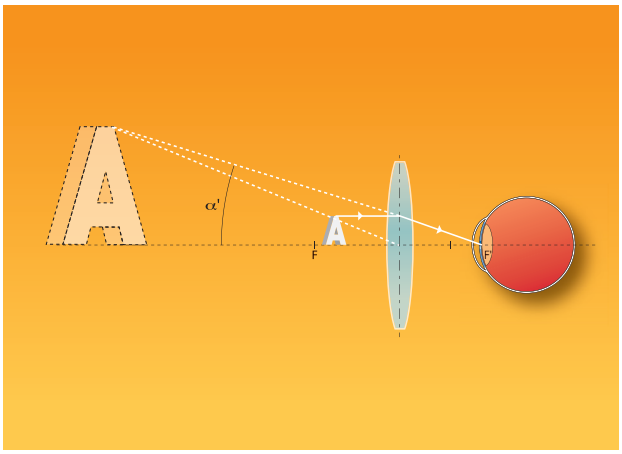
- If this image is projected to infinity, i.e. if the object being looked at is at the magnifier's first focal point, the eye perceives it without any effort of accommodation.
- If the observer brings the lens closer to the object, the image formed comes closer to the eyes and they must accommodate to keep the image clear; this can be done up to the point where the image is coincident with the observer's punctum proximum, the point where the eye applies its maximum accommodation. Magnification will then be at its greatest but the comfort of observation will be less.
- The focusing range, that is to say, the depth of field in which observations remain sharp, is the extent of the user's accommodation range through a magnifier. These data vary with the observer. It will be understood that an elderly person, whose accommodation effort is greatly reduced, has much less of a focusing range than a child or young adult using the same magnifier and still having wide amplitude of accommodation.

3. Advantages and Disadvantages

Magnifiers are familiar systems and simple to use. There are numerous models, allowing them to meet each person's specific needs precisely.

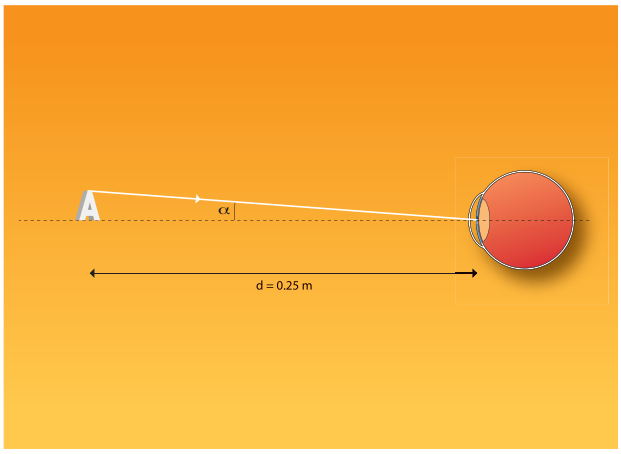
As a general rule, the stronger the magnifier, the smaller its diameter will be and the field perceived through it is as reduced as it is powerful.
The best way of using a magnifier is to position the eye close to it at its image focus, in order to obtain the greatest possible field of view and then bring the object closer to it until a sharp image is obtained. That requires bringing the patient's accommodation effort into play. In the case of elderly people whose amplitude of accommodation is greatly reduced, it is essential to provide the useful addition offering a sharp vision at near vision, prior to any trying of a magnifier. Magnification is then at its optimum when the image of the object perceived through the magnifier is projected to the far point of the patient's near-vision accommodation range through the near-vision correction.

Figure 23: *Optical principle of the magnifier:*



© Essilor International

a) Optical principle.



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b) Conventional distance of observation (of 0.25m) used for the Nominal Magnification definition.

Magnification of a Magnifier

Generally speaking, magnification using an optical system is the ratio between the apparent angle presented by the object seen via the system and the apparent angle it would present seen without the system.
In the case of instruments intended for the observation of distant objects, the magnification is constant, and defining it presents no ambiguity. In the case of a magnifier, which is intended for looking at objects brought close to it, magnification varies according to the observation distance used and the user's position: it increases with increasing observation distance separating the magnifier from the object, and with decreasing distance between the observer and the magnifier.

In order that magnification may be quantified and comparisons made, it has been chosen by convention to define magnification under the following two conditions:
• operation of the optical system under its intrinsic power, i.e. with the eye of the observer placed at the image focus (figure 23 a);
• conventional distance of the object observed with the naked eye of 0.25 m (figure 23 b).

The Nominal Magnification, M, is therefore defined by the ratio of the angle presented by the object through the magnifier, with the observer placed at the second principal focus, to the angle presented by the object when placed at the conventional distance of 25 cm. It is easy to show, for an object of size y, that the Nominal Magnification is given by:

$$\mathbf{Gc = \alpha' / \alpha = (y / f') / (y / 0{,}25) = 0{,}25 / f' = F / 4}$$

where F is the optical power of the magnifier.

Thus, we find that the Nominal Magnification, M, is equal to one quarter of the equivalent power of the magnifier, so that a magnifier with a power of +8.00 D has a magnification of 2x, a magnifier of power +12.00 D a magnification of 3x etc. Since magnification is a ratio of angles, it has no units but usage requires that it be represented by a multiplier, symbolised by the operator "x".

In reality, however, manufacturers refer to magnification in one of two ways:

either $\mathbf{M = Power / 4}$ or $\mathbf{M^* = (Power / 4) + 1}$,

the latter being more advantageous for low-power magnifiers (since a +4.00 D magnifier would only have a magnification of 1x if defined as M = F / 4).

For low vision, we use M = Power / 4 corresponding to the magnification required (which we will learn to assess later) and we have adopted the practice of defining magnifiers by their power and not by their magnification, in order to prevent any confusion.

In practice, the effective magnification of a magnifier depends on the observer: it is a function of their maximum amplitude of accommodation. The greater this amplitude, the closer the patient can get to the magnifier and focus on the image of the object formed by the magnifying glass. The younger patient can see closer, enjoy a bigger image and thus see better. This explains the differences in visual performance that can be observed between a young patient and an elderly person with identical visual acuity, using the same magnifier.

We generally divide magnifiers into three categories: low-magnification magnifiers (M up to 3x), medium-magnification (M between 3x and 10x) and high-magnification (M above 10x).

4. Different Types of Magnifiers

Manufacturers' catalogues offer a large number of magnifiers of all types: from the pocket sized illuminated magnifier owned by the majority of visually impaired people, since it is very useful in everyday life, to the illuminated magnifier on an articulated arm or even an illuminated stand magnifier providing magnification of up to 10x or 12x.

Figure 24: *Different illuminated magnifier models:*

© Essilor International

a) Hand magnifier.

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b) Stand magnifier.

© Essilor International

c) Adjustable stand magnifier.

D Spectacle Magnifiers or Microscopic Systems

To enable the magnification of the images of objects brought close, as an improvement on hand held magnifiers, magnification systems placed directly in a spectacle frame can be offered to visually impaired people. These magnifying systems are also commonly called "microscopic systems", a reference to the fact that their optical principle is similar to that of a microscope (even if their appearance is very different!), and also in opposition to "telescopic systems" used for viewing remote objects (see below). They are also called "frame-mounted microscopes".

1. Description

Spectacle magnifiers or microscopic systems are high-power plus lenses that are fitted to a pair of spectacles. They may be simple high-power single vision lenses, high-optical-addition bifocals or thicker optical systems (figure 25). The working distance is set by the power of the lens; it is generally much shorter than a patient's usual working distance.

These systems may be adapted in monocular vision for all lens powers available from +4.00 D to +48.00 D, i.e. magnifications up to 12x, or in binocular vision for weaker powers between +4.00 D and +12.00 D, i.e. magnifications up to 3x.

These systems are highly valued by visually impaired people, since they have a similar appearance to the traditional spectacles worn by all and sundry; they stigmatise the visual deficiency to a much lesser extent and are very easy to use.

2. Principle

The corrective principle amounts to strongly "myopising" the patient, in order that, by coming closer to the new apparent distance point thus created, the objects can be perceived at a greater angle than from their customary observation distance.

These systems comprise one or more lenses and the observation distance is inversely proportional to their power: 25 cm for a power of +4.00 D, 12.5 cm for +8.00 D, 8.3 cm for +12.00 D etc... The focusing range (or depth of field), i.e. the range of distances where the object is perceived without blur, is limited; it depends on the user's maximum amplitude of accommodation.

Figure 25: *Spectacle magnifiers:*

© Essilor International

a) Example of a monocular lenticular lens.

© Essilor International

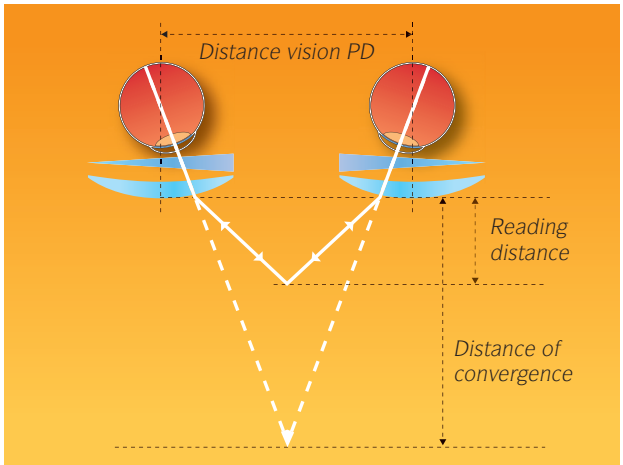
b) Achromatic monocular doublet.

To provide binocular vision, the working distance being relatively close (for a power of +4.00 D, the observation distance is of the order of 25 cm but for +10.00 D it is more like 10 cm), it is imperative to relieve the patient's convergence by incorporating base-in prisms into the lenses, which straighten the visual axis and improve binocular comfort (figure 26).

These prisms are combined with the strong plus correction. Their powers vary according to the power of the additions used and according to the manufacturer for finished products. These spectacles may be ordered pre-fitted from suppliers or produced in the optician's workshop with frames and lenses ordered from suppliers' regular ranges.

Figure 26: *Binocular microscopic system:*

a) Base in prisms relieve convergence.



b) Principle of prismatic spectacles.

Producing a pair of custom microscopic systems
It is possible to make these binocular systems to measure. In this case, the Low Vision Specialist recommends a small frame in which are fitted lenses of a power that is the sum of the distance-vision correction and the strong addition necessary for useful magnification in near vision. These lenses are either ordered in a sufficient diameter to ensure the necessary decentration to obtain the essential prismatic effect when fitting or ordered with the prism built in.

For example, for a client whose distance-vision refraction for the right eye is +1.50 D and for the left eye +2.00 D, who needs an addition of +8.00 D (G = 2x) to read the newspaper, the convergence prism is of the order of 8 Δfor each lens (addition value). So, we can order:

- Either a right lens with +9.50 D and a left lens with +10.00 D, both associated with an 8 Δbase in prism. This lens is produced as a special order and most frequently following a quotation.
- Or a right lens with +9.50 D and a left lens with +10.00 D whose diameters take into account the decentration required. The amount of decentration is given by Prentice's rule: c in cm = ΔF (where Δis the prismatic effect sought and F is the power of the lens) i.e. 8/9.5 for the right lens and 8/10 for the left lens, i.e. 0.8 cm or 8 mm for each lens in relation to the distance PD (i.e. Pupillary Distance).

Spectacle magnifiers are relatively simple to use and commonly supplied to persons with low vision. Their disadvantage is that they impose a very short distance of observation upon the patient: the greater the degree of magnification sought, the closer it must be. This puts a practical limit on their use. To offer more comfortable working distances and/or greater magnification, more complex optical systems can be used, such as those described next.

E Telescopic Systems

When the visually impaired person needs a high degree of magnification or the ability to observe at a greater distance, we can use more complex optical systems, called "telescopic systems", due to the fact that their optical principle is similar to that of a telescope and that, above all, they are intended for use in distance vision. There are two types of system: Galilean and Kepler. We look at them in more detail below.

1. Galilean Systems

a) Description

These systems are the oldest existing vision aids. They are small afocal Galilean telescopes for use in distance vision, to which a strong plus lens is added for use in near vision. They allow magnifications of between 1.8x and 3x for far vision and between 1.8x and 15x for near vision.

These systems are mainly used for distance vision and near vision (figure 27 a). They may also be adapted for intermediate vision, for example, for playing board games or watching television at mid distance.
For near vision, in comparison with spectacle magnifiers of identical magnification, they provide the visually impaired person with an appreciably greater and more comfortable observation distance.

b) Principle

These small spectacles are designed on the principle of Galilean telescopes, i.e. comprising a plus objective lens and a minus eyepiece or ocular lens, separated by a precisely defined distance. This magnifying optical system is afocal for its use in distance vision. For near vision, a plus lens, in the form of a "cap" is added in front of the objective lens.

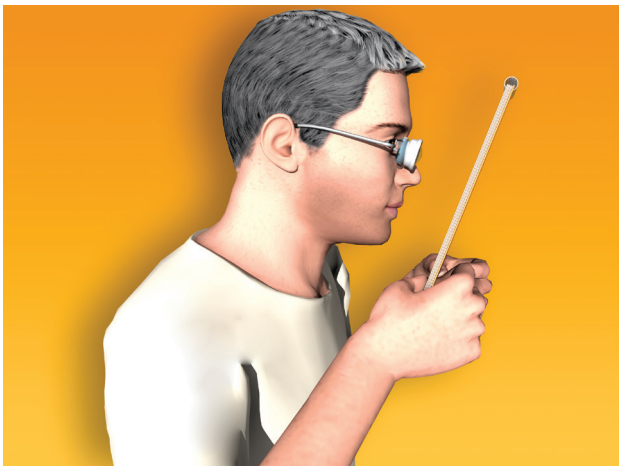
The magnification in near vision is the product of the distance-vision magnification system and the one of the cap, i.e. $M_{NV} = M_{DV} \times M_c$. The system's power results from that of the objective lens F_O and that of the eyepiece lens F_E, according to Gullstrand's formula, i.e. $F = F_O + F_E - d \times F_O \times F_E$ where d is the distance separating the objective and ocular lenses.

By adapting certain parameters, it is possible to define the characteristics of the Galilean system: for example,

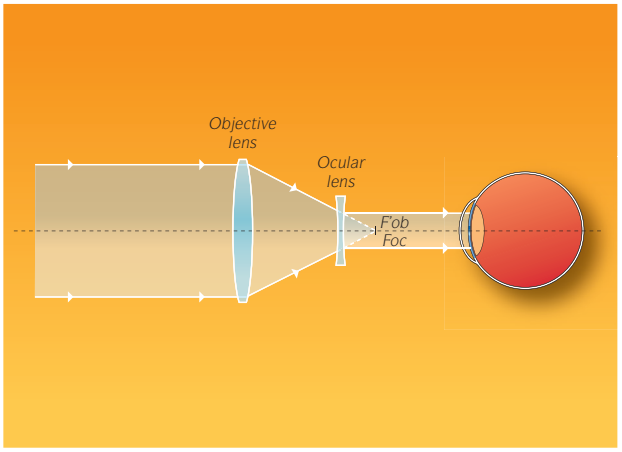
- by increasing the objective/ocular distance, the observation distance is extended,
- by reducing the ocular power, the field of vision is increased,
- by increasing the objective power, greater magnification is obtained.

This is why there are very many Galilean systems and why it is important to have a good understanding of their optical characteristics, in order to be able to meet the needs of the visually impaired as far as possible.

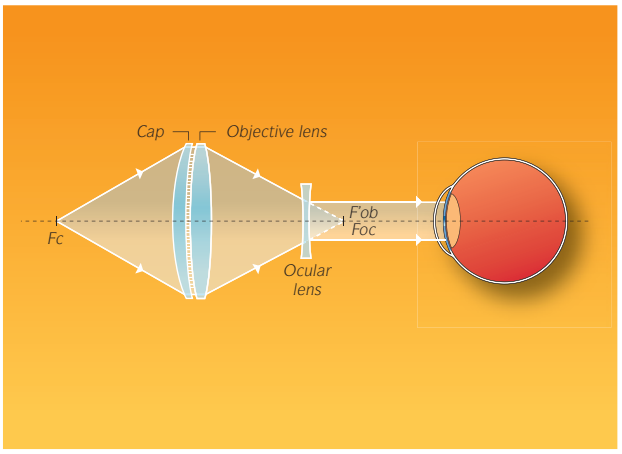
Figure 27: *Galilean telescopic system:*



a) Galilean system.



b) Galilean distance-vision principle.



c) Galilean near-vision system with a plus-power "cap".

c) Advantages and Disadvantages

As with the microscopic systems previously seen, the working distance remains short, although it is appreciably greater. The focusing range (or depth of field) depends on the patient's amplitude of accommodation: in elderly people it is more or less fixed, which makes their utilisation delicate; for younger patients, a focusing range exists. The field of vision is relatively narrow and reduces with increase in magnification.

Systems allowing both distance and near vision, through the addition of a cap, often prove to be the most practical, since they can be used for several activities. Also, these systems may be upgraded: in the event of aggravation of the vision problem, the near-vision magnification may be increased, simply by modifying the power of the cap, allowing the conservation of most of the device.
Systems that only allow near vision, with additional convex power built in, are more discreet, lighter and more compact than those for far vision.

The main advantage of Galilean systems is their practical aspect: they are easy to carry around and generally provide excellent image quality.

Increasing the Working Distance

It is possible to increase the reading distance for a Galilean system by increasing the magnification of the far-vision system and reducing that of the cap. For example, to obtain a 6x magnification in near vision, we could use a 2x (afocal) Galilean distance-vision system and add a +12.00 D cap, providing a magnification of 3x (2 x 3 = 6x); the theoretical working distance is then 8.3 cm. We could also use a 3x Galilean magnification system and add a +8.00 D cap with 2x magnification (3 x 2 = 6x) providing a theoretical observation distance of 12.5 cm. The downside of this extension to the observation distance is a reduction in the field obtained with the system. Thus, the most appropriate choice of system must take several parameters into account: the magnification sought for distance vision and near vision, the working distance in near vision and the fields of view required.

2. Kepler Systems

a) Description

Commonly called «Monoculars», Kepler systems are of a comparable design to terrestrial binoculars and allow focusing at different distances. They are especially for very long to intermediate observation distances and are used mainly when moving about for quick long-distance observations: for example, to read the name of a street, a display panel, etc. Some students use them to follow a lecture in the lecture theatre.

b) Principle

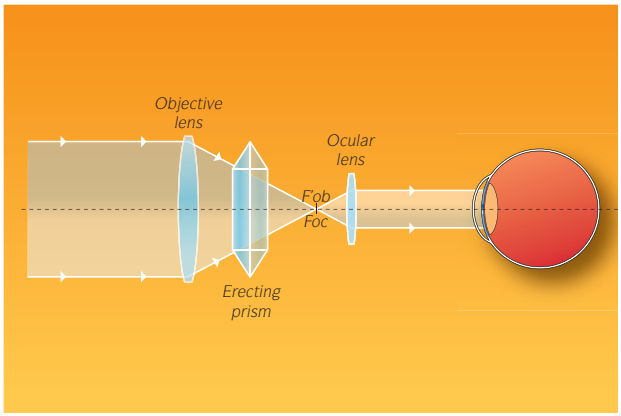
These systems comprise a convergent objective and eyepiece lens and also an image erecting prism positioned between the two.
Kepler systems offer magnification of between 2.75x and 10x. Moving the objective lens varies the sharp vision distance between infinity and 35 to 40 cm. As with terrestrial binoculars, the aperture, that is to say the diameter of the objective lens, regulates the quantity of light entering the instrument: the greater the diameter, the greater the brightness of the image and vice versa.

These systems are essentially designed for hand-held use. Some models may, however, be fitted to a pair of spectacles, in either monocular or binocular form, for prolonged observation (the student in the lecture theatre, for example).

Figure 28: *Kepler telescopic system:*

© Essilor International

a) Monocular Kepler system.



© Essilor International

b) Optical principle.

c) Advantages and Disadvantages

Kepler systems offer much greater distance-vision magnification than Galilean systems. The field of vision is limited and not greatly compatible with a significant loss of central vision. Although lenses usually have an anti-reflective coating, Kepler systems absorb a lot of light and may only be used in well lit environments.

Numerous magnifying optical systems can be used to assist visually impaired people: simple magnifiers, microscopic systems and telescopic systems. Their common principle is that they give the visually impaired person a magnified image of what they are looking at. These are the classic vision aids. To assist the visually impaired person in making a choice, it is necessary for the optician to know them well. It is always necessary for the patient to be trained in the use of the vision aid (section 4 c 5). Such aids are easy to use, they are portable and affordable. They are always a great help to visually impaired people. On the other hand, sometimes they only allow specific use or are limited to a particular task. This is why other magnification systems, like the electronic systems described next, can be an effective addition to the visually impaired person's equipment.

F Electronic Magnifiers

Among electronic vision aids, we usually distinguish between, on one side, video magnifiers, large heavy and not readily transportable systems and, on the other side, completely portable electronic magnifiers. The general principle is identical: a camera generates a magnified image of the object, text etc. on a viewing screen, which may or may not be integrated into the system, or on a television screen.
These systems are generally greatly valued by visually impaired people, since they allow much greater magnification than optical systems and provide binocular vision, as well as a much more comfortable working distance. Also, they allow a real image to be seen, more pleasant to look at than a virtual optical image and offer amplification or contrast-inversion possibilities that encourage visual efficiency.

1. Video Magnifiers

With these systems, the camera is usually fixed on a vertical support and the document to be looked at is moved in front of the camera, either on a mobile XY table or by hand.
The viewing screen may be simply the person's television set, an independent multimedia screen positioned beside the magnification system, or even a screen fixed onto the system with a movable attachment arm to ensure visual and sitting comfort.

These devices provide greater magnification possibilities and are recommended for people whose vision is severely deficient and for long periods of work. A great many near-vision activities are possible with these systems: reading, writing, small tasks using one's hand, craftwork etc. These are the devices most often used to equip work stations. Their numerous possibilities – choice of size of screen, ability to work in a network etc. – allow adaptation to a great many professional situations.

Using a video magnifier is not as simple as it seems. It is quite disturbing for the visually impaired person as it imposes a different coordination between the eye and the hand and necessitates a modification to the reading strategy. However, once accustomed to the magnifier and trained in its use, the user will derive great benefit from it.

Figure 29: *Electronic magnifiers:*

© Essilor International

a) Fixed video magnifier.

© Essilor International

b) Mobile magnifier connected to a television set.

2. Handheld Electronic Magnifiers

More and more visually impaired people wish to be fully mobile with their electronic systems. This is why manufacturers are designing lighter and more portable systems, providing access to information under any circumstances.

Such a system includes a small screen that makes easy viewing possible in all situations and offers the same functions as magnifiers: real images, varying levels of magnification (usually between 3x and 20x), amplification and inversion of contrast, a standardised working distance, the possibility of binocular vision, etc. Used more and more and handled like simple magnifiers, they do not disturb hand/eye coordination since the person looks directly at the screen positioned over the document. Only the movement strategy for the electronic magnifier has to be worked on (section 4 C 5).
Electronic magnifiers are extremely user-friendly aids but, more often than not, are used only occasionally, particularly by those for whom the screen is too small.

Figure 30: *Handheld electronic magnifiers:*

© Essilor International

a) Ultra-light model for reading and writing.

© Essilor International

b) Stand alone model.

3. Magnification Software

For computer uses a magnification software is a very interesting solution and an economic alternative to magnification devices. It allows the use of common tools and strategies, such as the use of a mouse in selecting various commands, viewing all files accessible and simply accessing the Internet in readable contrasts and fonts. On the other hand, it does not allow printed documents to be read, unless they are scanned or unless an electronic magnifier is connected to the computer.
A voice synthesiser may be linked to this software; it is used by the seriously visually impaired who can only read for a few moments or by avid readers who wish to alternate with reading in black and white, for example, when doing work over a long period or when their visual status is less effective.

G Daily Living Aids

A certain number of vision aids are not optical in nature: these are aids used in daily life, specifically and ergonomically designed fort the comfort of visually impaired people. Listed below are a few examples:

1. Hats, Caps, Sunshades etc.

Protecting the visually impaired person against light is an important factor in the quality and comfort of their vision. Hats, caps and sunshades etc. can be of great assistance in daily life. If the hat has a wide brim or the cap a long peak, the face is kept in the shade: the patient's eyes do not receive direct sunlight and there is much less glare.

2. Large Print

Simple adaptations to objects in daily life can greatly improve a visually impaired person's comfort in daily life and save him/her from constantly having to use optical or electronic aids. These "aids" show them strongly contrasting elements (black on a white background or white on a black background), of a size sufficiently to be perceived by the naked eye or equipped with the usual reading glasses. First of all, we should mention books in large print but there are telephones and computer keyboards with large keys also, and even watches, alarm clocks, scales and thermometers with large displays. There are also board games adapted for visually impaired people.

3. Tabletop Reading Stands

We have seen in previous chapters how most visually impaired people are compelled to read at a distance that is unusually close and must be maintained fixed. Portable reading stands, made of wood or plastic, tiltable according to need, can help them considerably, while maintaining the body in the most ergonomic position possible.

4. Voice Systems

Visually impaired people can even find precious assistance in the use of talking systems. There are a number of them, such as audio books, mobile phones, voice synthesis software, talking thermometers, watches and even scales and many other domestic appliances. Visually impaired people can therefore call upon another of their senses, hearing, to compensate for their failing vision.

Daily living aids are usually extremely simple to use. They are extremely useful to visually impaired people in their daily lives.

Figure 31: *Daily living aids:*

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a) Example of a telephone with large buttons.

© Essilor International

b) Illuminated reading stand.

4. Rehabilitation of Visually Impaired People

Rehabilitating visually impaired persons consists in helping them to find a better quality of life by **adapting themselves to their deficiency** and choosing **technical vision aids** that allow them to carry out specific desired activities. A person is visually impaired from the moment he/she gets up in the morning until he/she goes to bed at night and cannot hope for any restoration of his/her "previous vision". On a daily basis, he/she can only seek to make do with the deteriorated vision; the treatment aims to assist him or her in this.

We saw in chapter 2 that ocular conditions can cause three types of disorder: disorders of central vision, disorders of peripheral vision and overall disorders (central and peripheral). These disorders cause incapacities and disabilities that, in the first place, should be evaluated during a functional assessment of vision. Starting with this knowledge of the development of the patient's visual capabilities and their goals, a vision aid can be proposed.
In this chapter, the different stages in helping a person with visual impairment are looked at.

Definition of disabilities and handicaps according to the international classification of disabilities:
The organic disorder creates an impairment: the disability expresses the limits in terms of how the person, who can no longer carry out certain tasks, operates and the handicap expresses the social disadvantage caused by the disability.

A Refraction, an Essential Prerequisite

This stage consists in optimising the person's sight prior to any care towards rehabilitation. Too often, people afflicted by sight-threatening conditions no longer wear their glasses, as they only provide a subtle improvement in vision. However, we cannot imagine developing visual functions and selecting vision aids, if the image on the retina is not optimised and clear to start with. Indeed, one of the golden rules in Low Vision is **"not to enlarge a blurred image!"**

1. Interview

Since every visually impaired person is a unique case, this stage in rehabilitation process allows us to understand the personal circumstances of the individual. It is an important time for listening and often it is an emotionally charged stage. The patient recounts the development of the illness and the daily restrictions that it imposes; they talk of their anxiety about the future in terms of loss of vision but also of loss of independence. They frequently compare activities in the present with those of the past, tell us about their disappointment, showing us a magnifying glass or some other vision aid acquired on chance encounter or given to them by a relative who attempted to help them.
This interview, an essential part of the assessment, provides a clear picture of the patient's requirements. By analysing the essential acts of daily life (preparing meals, washing, reading a letter, driving a car etc.) it is possible to assess the difficulties encountered. The same is true for "leisure" activities (painting, sewing, DIY, embroidery, stamp collecting etc.). The requirement is different for every patient and it is therefore necessary to adapt our theoretical and technical knowledge to each person's needs and desires.
Particular attention should be paid to the patient's motivation: it is, in effect, essential that this motivation comes from the patient themselves and not from those around them, since this is what will be used to construct an action plan based on the patient's centres of interest. It is also important to evaluate those close to the patient both in terms of their availability and encouragement and in terms of over-protection.
Finally, it is important to know the prognosis of the ocular condition, the various treatments administered or in progress and the patient's general condition. For example, a patient suffering from tremor of the hands will have greater difficulty with some optical aids than with others.

Finally, this stage is a special moment for explaining to the patient and those around that their functional vision will be more effective and more comfortable if they exercise the eyes regularly and with determination but that no improvement in the vision as such can be hoped for. Only suitably chosen vision aids can bring an apparent gain in visual acuity (section 4 C).

Figure 32: *Interview:*

A time for listening that allows the visually impaired person's actual needs to be identified, while creating the climate of trust, essential for the provision of good treatment.

2. Refraction

In the preamble to the vision examination, we should remember that visual acuity is not a representative measurement of the patient's effective remaining vision but only an objective assessment of macular function and therefore a measure of the loss of power of fine discrimination. Optimising the residual visual acuity by a careful refraction allows the various assessments and exercises of the visual functions to be carried out under optimum conditions. It also helps to deduce the characteristics of the vision aid necessary for carrying out properly defined activities. Generally, loss of focus of the retinal image results in a choice of excessive magnification and visual discomfort due to persistent blurring.

Equipment Used: Trial Frame and Lenses

The trial frame and a set of full-aperture lenses are the preferred tools for carrying out refraction on a visually impaired person. The patient may thus adopt a comfortable head position, whereas a phoropter imposes a very precise head position and creates a largely unfavourable tubular field for the best visual effectiveness. The person's own prescription, or the result of an auto-refractometer, is placed in the trial frame pair and monocular visual acuities are measured, followed by the binocular visual acuity. It is possible to verify the accuracy of the refraction with the following method. An afocal distance-vision telescopic system (Galilean type) 1.8x or 2.1x magnification is placed in front of each eye and it is ensured that acuity is indeed improved by a factor of 1.8 or 2.1, depending on the system used. In the event that an improvement in vision is not obtained, it is essential to refine the optical correction and so verify the refraction.

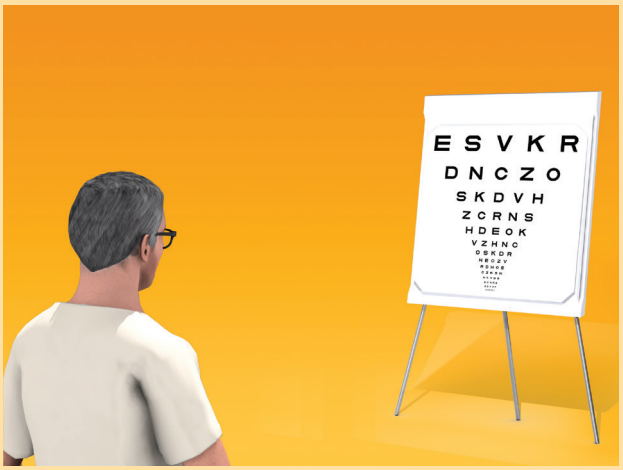
Assessment of Visual Functions: the Charts of Visual Acuity

These measurements may be made using optotypes from a test projector, projected at 2, 3 or 4 metres or using an ETDRS logarithmic progression printed chart, for example. Each line of acuity comprises five letters; when at least three of them are read, the corresponding acuity is attributed. Charts can usually be used from 4 to 1 m. Several studies have shown that the optimum distance for visually impaired people is 3 m, where this is technically possible.
Some of these charts offer high contrast letters, black on a white background, and varying contrast or decreased uniform contrast letters. The latter are particularly useful in assessing contrast sensitivity in the visually impaired and their possible need for tinted filter lenses. We will come back to this later.

ETDRS Acuity Charts

ETDRS visual acuity charts are logarithmic charts that were designed in the 1990s during a study on assessing the vision of patients affected by diabetic retinopathy called the **E**arly **T**reatment **D**iabetic **R**etinopathy **S**tudy; the name was retained.
They comprise 14 lines of five letters, whose geometric progression follows the common ratio 1/1.2599, i.e. the cube root of 2. Thus the visual angle subtended by the optotypes is divided by 2 and therefore, visual acuity is multiplied by 2, every three lines.
Visual acuity is considered as achieved if three letters on the same line can be deciphered. These charts may also be easily brought nearer to the person in the case of low visual acuities: acuity is then divided by the ratio of the distances. For example, if the visual acuities are scaled from 20/200 (6/60) to 20/10 (6/3) for a distance of 4 m, they are divided by 4 if the scale is used at a distance of 1 m. Thus, in this case, they are scaled at between 20/800 (6/240) and 20/40 (6/12).

Figure 33: *Example of an ETDRS chart:*



Refraction of the Visually Impaired Person:

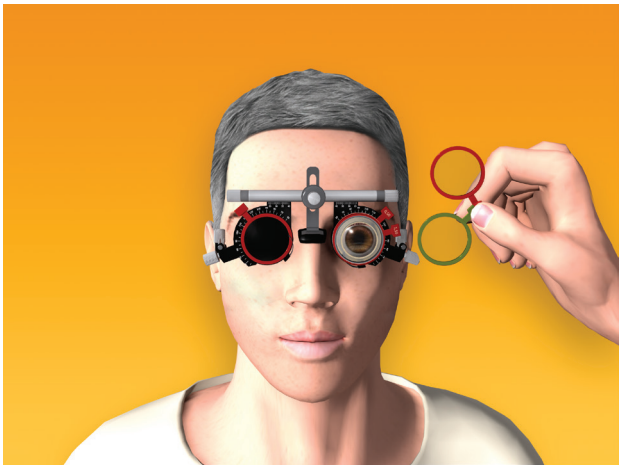
This may be done using what is known as Von Rohr's method, i.e. entirely with the 1.8x or 2.1x Galilean system, or without it, in order to preserve natural vision conditions: vision not magnified, normal head position, most effective direction of gaze, particularly when the person leans or tilts the head to one side.

a) Von Rohr's method

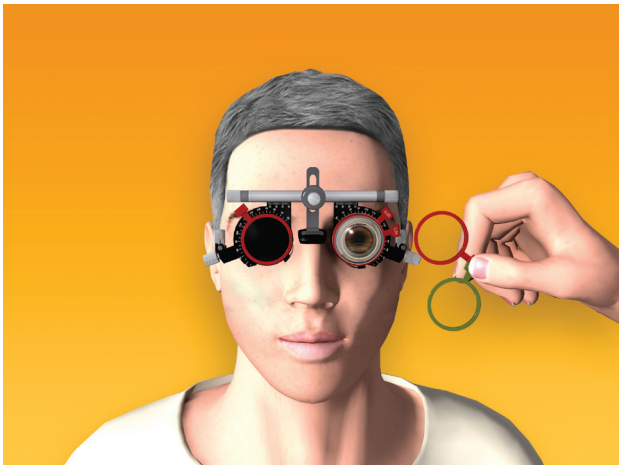
This method is usually chosen when the acuity of the person to be examined is very low or when only fixed optotypes are available or their size too small to be perceived comfortably.

Refining monocular correction starts with verification of the sphere: spherical lenses are placed into the trial frame in steps of 0.50 D at the Galilean eyepiece level, in order to find the sphere providing the best acuity. This sphere is, as with any refraction, the one for which a +0.50 D lens creates a blur and -0.50 D does not provide any improvement in acuity.

The cylinder is verified using Jackson Crossed Cylinder of +/-0.50 D placed in front of the Galilean system, i.e. at the objective lens plane. The cylinder axis and then the power are verified according to the customary refraction method by using a line of letters rather than the cloud of dots, the latter being generally difficult to understand and to perceive for visually impaired people. The examiner proceeds as for any refraction: to verify the axis of the cylinder, the crossed cylinder handle is placed according to the direction of the axis of the worn cylinder, the axis of the crossed cylinders is placed according to the axis of the corrective cylinder, to verify its power.

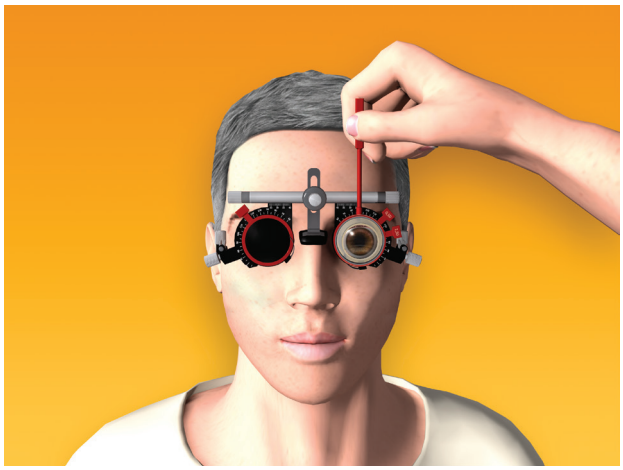


a) Verification of the sphere with a sphere of +0.50 D.

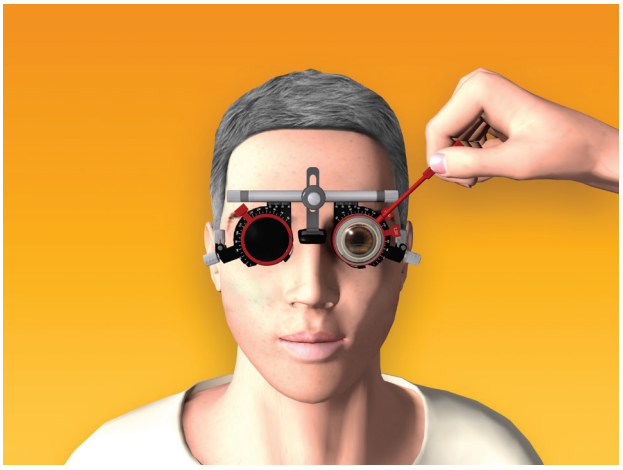


b) Verification of the sphere with a sphere of -0.50 D.

Figure 34: *Von Rohr's method:*



c) Verification of the axis (oriented at 90°).



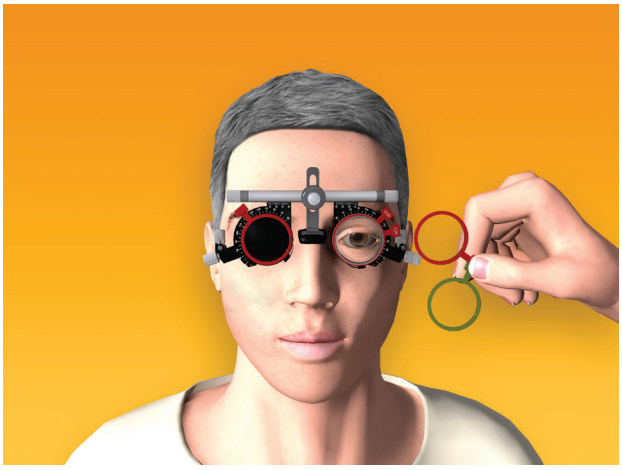
d) Verification of the power.

b) Classic Method

This method is the most natural and should be given preference, wherever possible.
The patient is given his/her previous prescription or the objective refraction measured by an auto-refractometer and placed in the trial frame.
The examiner ensures that the person can read several levels of letters on the acuity chart presented. If this is not the case, he chooses a distance that does allow this to occur and places the lens compensating for the accommodation corresponding to the chosen distance at the back of the trial frame: +0.50 D for 2 m or +1.00 D for 1 m.

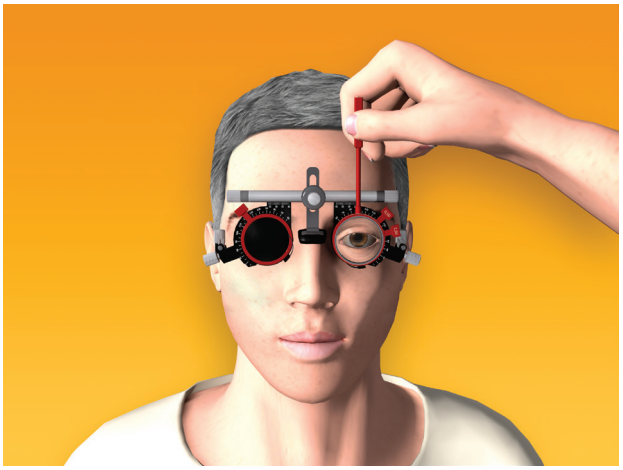
Verification of the Sphere:
This stage consists of identifying the best acuity sphere, using steps corresponding to the patient's retinal sensitivity, and then narrowing it down. When the visually impaired patient does not perceive a difference between the correction in place and +0.50 D or -0.50 D, this may be because the correction being worn is over-correcting by -0.50 D or because the person does not have sufficient retinal sensitivity to perceive these differences. We then increase the power steps in the test spectacles (+ or -0.75 D; + or - 1.00 D etc.) progressively, until a loss of acuity is perceived with the convex lens. Once this operation has been completed, the customary refraction process is resumed.

Figure 35: *Verification of the sphere with + and - 0.75 D spheres:*

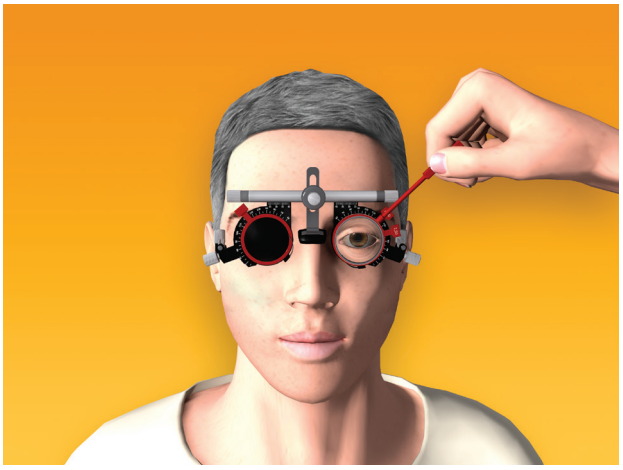


Determining or Verifying the Cylinder
The next step consists of verifying or determining the axis and the power of the cylinder using the customary refraction method, by choosing a crossed cylinder corresponding to the patient's retinal sensitivity (often +/- 0.75 D or even +/- 1.00 D) and by using a line of letters in the test, which is easier for the visually impaired patient to analyse than a cloud of dots.

Figure 36: *Determination or verification of the cylinder, using +/- 0.75 crossed cylinder:*



a) Verification of the axis (oriented at 90°).



b) Verification of the power.

Verification of the Emmetropisation
In order to be sure of the emmetropisation of each eye, an afocal Galilean telescopic system with a magnification of 1.8x or 2.1x is placed in front of the prescription found and it is checked that acuity is indeed improved by a factor of 1.8 or 2.1, according to the system used. In the case where such an improvement in vision is not obtained, it is essential to refine the prescription by proceeding as previously outlined.

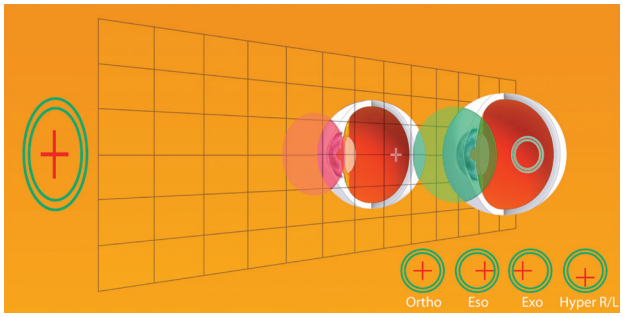
c) Binocular Balance

Binocular balance is obviously performed, each time that there is iso-acuity. The alternate obscuring method is simple, quick and effective but the dissociation by prisms method can also be used. In each of the two methods, care is taken that the line of letters displayed is indeed visible by each eye.
However, in most cases, this is very difficult, even impossible, to do, since both eyes have very different visual acuities (aniso-acuity). With young visually impaired people and all those who still have accommodation effort, an attempt is then made to achieve an accommodating balance with the polarised red/green test, for example.

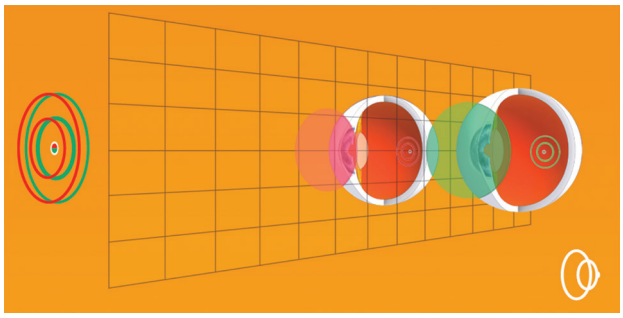
d) Binocular Vision

Binocular vision is tested very simply: it is not actually of very good quality for the reasons set out above but it is important to know whether it exists for later vision aid tests. Indeed, if binocular vision provides comfort and better perception for the person examined, it should be preferred whenever possible, during tests and the adaptation of aids. Measurement may consist simply of comparing monocular acuities with the binocular one and the latter should be better. Polarised binocular vision tests cannot generally be used, since the acuities encountered are too low. On the other hand, red/green tests, such as Schöber's test and Brock's rings can be carried out quite easily.

Figure 37: *Verification of binocular vision:*



a) Schöber's test: the subject wearing red and green filters perceives the red cross at the centre of the green circles if the patient fuses well. If he/she perceives either the cross or the circles, there is suppression in one eye; if the cross is not in the centre of the circles, there is heterophoria.



b) Brock's test: the subject is fitted with red and green filters. If there is fusion and stereoscopy, the patient perceives a funnel. This means that the large circle will be perceived in front of or behind the little circle.

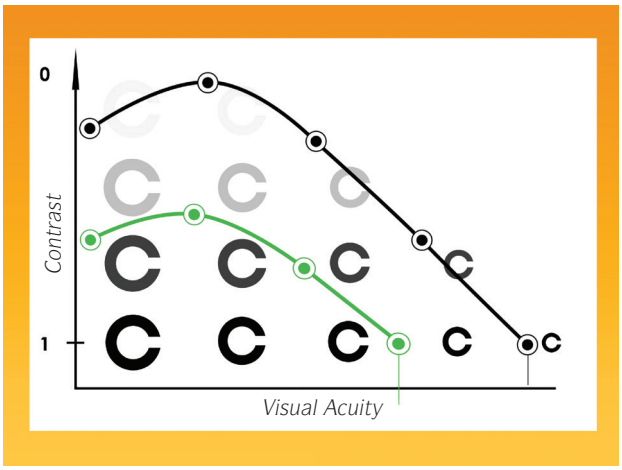
e) Perceptual Appreciation

It is checked in very distant vision or at infinity, for example, through a window or even directly, when outdoors. If the refraction was done at a closer distance than the standard distances of 4 to 6 m, it is essential that the plus lenses, intended to compensate for the accommodation effort brought into play in the previous measurements, are removed.
With the refraction complete, it is essential to adjust for distance vision regardless of the refraction method used. By placing a +0.50 D lens in front of the patient's eyes, their distance vision should lessen; with a -0.50 D lens, perception should remain stable. Where acuities are very low and retinal sensitivity weak, this test is done with +0.75 D and -0.75 D lenses.

f) Appreciation of the Perception of Contrast

It is essential at this stage in the examination, to assess the perception of contrast of the person, in order to gain a better understanding of the difficulties that they encounter in daily life. Reading black characters on a white background in a book is similar to many of the measurements made during classic refraction but reading black letters on a red or blue background in a catalogue, for example, is very different.
As we have seen previously, some ETDRS scales and some projectors offer optotypes of different or varying contrast that allow this measurement to be made simply.
The method is as follows: the different size of letters are firstly presented at maximum contrast, then at weaker and weaker contrast (usually five contrast levels are used). For each size of letter, the contrast is noted at which the person is still able to decipher, with the next level no longer being perceptible

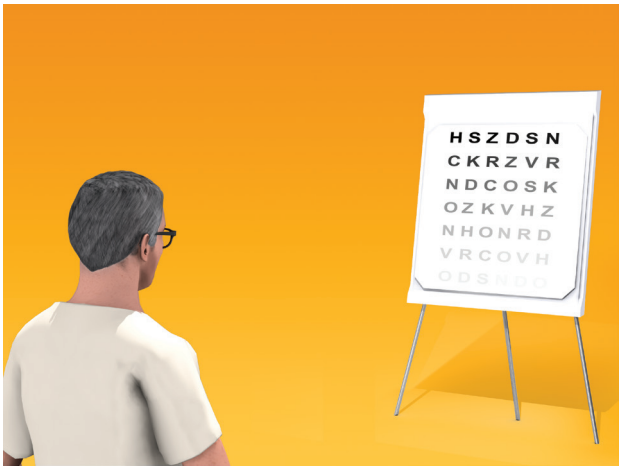
Figure 38: *Perception of contrast:*



In black, the contrast perception curve for a normal patient; in green, the contrast perception curve of a visually impaired person. Elements situated between the two curves are not perceived by the visually impaired person who has a reduced perception of low contrast and high spatial frequencies (does not perceive details).

We should note that it is possible, at this stage, to assess the gain in contrast that wearing chromatic filter lenses can provide. The following method is used: the patient reads the smallest readable line of letters at maximum contrast, then the contrast of this line is reduced until he/she no longer perceive the letters. The chosen filter is then placed in front of the patient's eyes and he/she is asked whether the letter that had disappeared has become visible again. If such is the case, the contrast is reduced again, until the letter disappears. The number of letters read with the assistance of the filter indicates the gain in contrast provided by the filter. For example, for a patient whose corrected visual acuity is 20/100 (6/30), who reads letters with 100%, 50% and 25% contrast with difficulty and reads 25% and 12% more easily with a filter, we deduce that the filter provides 12%to 15% of additional contrast.

Figure 39: *Contrast threshold chart:*



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B Managing the Rehabilitation of a Visually Impaired Person

1. Assessing Visual Functions

The purpose of this assessment is to methodically evaluate the visually impaired patient's visual potential and its limits.

a) Sensory Assessment

- *The measurements of distance monocular and binocular visual acuities* are taken with the optimised prescription worn by the patient. Visual acuity at near vision is measured at the distance specified by the selected chart and then at the distance chosen by the patient. The position and movements of the head are noted.
- *The assessment of the visual field,* i.e. the extent of the space perceived in monocular vision, when the eye (or both eyes the binocular visual field is being measured) fixes on a point directly in front, is usually done with the assistance of a Goldmann perimeter that allows a map to be made of the residual sensitivity and also one for the extent and intensity of the loss. This test can be performed with both eyes open for a binocular visual field test. These results are compared with those obtained with the Amsler grid test, in order to assess any subjective scotomas.
- *Reading ability* is assessed by a reading test, in order to be able to measure the cognitive capability to recognise characters, and their grasp over time. A number of calibrated charts provide texts, whose fonts vary in shape, body, bolding and line spacing. Difficulties encountered are noted and the reading speed recorded.
- *Fusional reserves and binocular gains* must be studied for quality. It is important to assess them, in order to be able to improve them, if the patient can benefit from a binocular vision aid. They are developed with targets adapted to the patient's vision, the choice of the size of characters to be read being made in relation to visual acuity, for example. Good fusion can be a problem when using monocular equipment, the partial or complete occlusion of the other eye sometimes being necessary. We will address this point in greater detail at the end of this section.

Figure 40: *Sensory assessment: Example of a reading ability chart for near vision (french version):*

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b) Assessment of the fixation and eye movements

- The quality of fixation and the existence of a possible eccentric fixation should be assessed in case of central vision loss. The patient is guided in the search for the most favourable retinal zone. Then its use during eye movement (smooth pursuit, saccades and vergence movements) is analysed. The ocular motility is highly dependent on the nature of the fixation. In cases of impaired peripheral vision, our attention focuses on the analysis of saccadic movements, the only ones to be disturbed.
- *The motor dominant eye and the fixating eye* are highlighted; knowing which is which is necessary when adapting a vision aid.
- The organisation of the *eye/head coordination* is observed: eye movements should normally anticipate head movements.

c) Functional Assessment

Functional vision results from a combination of motor and sensory functions. The overall functional vision plays a role in the social interaction. Functional assessment consists of evaluating whether the vision impairment disrupts the gaze and therefore complicates communication ("when I talk to someone, I can no longer see the expression on their face"), whether it slows down the access to information ("I can no longer read station signs when I'm in a train") and whether it disrupts the organisation of movement ("I look to one side").

Figure 41: *Aiming exercise: To ensure that the person correctly coordinates movements with fixation, in order to locate correctly:*

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Reminder of the functional signs of an impaired central vision:
- Reduced distance and near visual acuity.
- Loss of colour vision and contrast sensitivity.
- Disruption of depth perception.
- Inability to read or write.
- Inability to coordinate eye and hand accurately.
- Inability to discriminate: decreased facial recognition.
- Difficulty directing the gaze: inability to carry smooth pursuits.
- Feeling of loss of balance when walking.

Reminder of the functional signs of an impaired peripheral vision:
- Reduced visual field.
- Reduced perception of movements.
- Deterioration of the recognition of shapes and contours.
- Inability to direct the gaze.
- Deterioration of the visual exploration with difficulty understanding surroundings.
- Difficulty with spatial orientation.
- Reduced night vision.
- Partial or total loss in mobility.

2. Developing the Residual Functional Vision

The purpose of this stage is to develop compensations for the defective functional vision and to improve the effectiveness of the residual vision. We are entering the field of **rehabilitation**, for which the aim is not to return to the prior functional state but to mitigate present difficulties, as far as possible, so that the visually impaired patient can increase their independence and improve their quality of life.

The principle is to teach the patient to see "in a different way" by favouring the zones of the retina that remain functional, by controlling the visual environment – lighting, contrast, glare – and by preparing, using specific exercises, for the best usage of a magnifying vision aid.
This work is always customised according to the person's visual abilities and their centres of interest. It varies according to the vision loss and its extent.

a) In Cases of Central Vision Loss

Fixation and eye movements
The basis of care consists of finding, developing and anchoring a new fixation (or fixations) in a preferred area of the retina. For this, targets varying in size are presented on a uniform and contrasting background. The instruction is to perceive the object as precisely as possible to start with, then, with training, to be able to spontaneously find it again from any direction. This fixation only becomes effective when it is then used in a stable way in smooth pursuit movements, by maintaining the new fixing zone on the target in a continuous horizontal, vertical, oblique or circular movement. Then in saccades, the attention is focused on the accuracy at the end of the movement. The instruction is to look consecutively, with as much accuracy as possible, at two targets presented horizontally. A good anchoring of the eccentric fixation allows the target to be found without overshoot or undershoot.
Since reading is only a succession of fixations interspersed with saccades, improving it is highly dependent on this part of the rehabilitation.
Vergence movements are developed with targets adapted in size and contrast to the person's vision. They are in high demand when using optical aids that often require working at close distances.

Eye-Hand Coordination
The deterioration of the visual information has a negative effect on the ability to perform tasks and, in particular on eye-hand coordination. With the eye movements reorganized, it is important to add hand movement to it. Eye-hand coordination means making a movement under visual control, more precisely, the result and accuracy of the movement are managed by the central retina, while the peripheral retina perceives the movement and the projection of the movements of our body.

Thus, the aim of this work is to re-programme the visual location in the new fixation zone, in order to assist the patient in making these everyday movements by adjusting the "new way of seeing" to the eccentric fixation. With training, this new location becomes the new "straight in front", i.e. the main location direction, the role that the macula had before the onset of the disease.
As shown in figure 42, the patient in the process of rehabilitation, perceives the ball presented to him, using his new fixation zone. Since the organisation of the movement is still linked to the macula, the main reference for localisation since birth, the index finger misses the target.

Figure 42: *Eye-hand coordination exercise:*

Manual mislocation due to a still unstable coordination between fixation and movement.

Discrimination
Discrimination is the ability to perceive, identify and recognise an object from an analysis of its shape and orientation and to differentiate that object from the background on which it appears. This work brings into play the ability to simultaneously reference, register, scan and visually identify. The new fixation zone, operating as a reference, is then used in the recognition of symbols and images. The patient is asked to find and recognise a letter and then an image, isolated on a page. The aim is to combine the recognition of the shape with the perception of fine detail. All exercises are organised with gradually increasing difficulty. As shown in figure 43, the jigsaw in general is recognised by the peripheral retina. As to the details of a piece, the patient observes using their eccentric fixation, assisted by a magnifier. Visual training continues with reading words and then texts, firstly in a type size that is accessible to the patient, in order, little by little, to access common type sizes, those in books, magazines and newspapers. This work is most often done using magnifying aids.

Figure 43: *Analysis of the details of a jigsaw assisted by a magnifier:*

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Writing
The writing task is differentiated according to two modes that require different performances:

- What is termed "administrative" writing, which consists of filling in a form or a cheque, for example, requires precise discrimination, associated with referenced eye-hand coordination to complete the required documents. Most often, an optical aid is necessary to access characters which are often very small and poorly contrasted in such documents.
- What is called "affective" writing of a letter or birthday card, for example, requires less precision. The simple referencing of the edge of the page by the retinal periphery, by creating a maximum contrast between the edges of the page and the background support quickly allows the patient to write horizontally, by allowing the kinaesthetic memory of the "writing" movement to resume in the way that it is accustomed to.

b) In Cases of Peripheral Vision Loss

Fixation and Eye Movements
Vision plays an essential role in the ability to move about, due mainly to information provided by the peripheral retina.
In cases of peripheral impairment, the fixation on a target is usually stable. Pursuit movement is possible, thanks to macular capture but is only effective if the target is moving slowly. Saccadic movements are induced by the peripheral retina; whether voluntary or initialised by stimulation, they are often greatly disrupted.
A scanning strategy should then be put in place, to develop anticipation faculties that are necessary for balance and mobility.
The relationship of "head/eye" movements is also disrupted, since eye movements are no longer triggering the head movements but often come after them. Awareness and repetition will allow normal function to be rediscovered.
It is by finding a harmonious ocular motility strategy again that the patient becomes effective, less easily tired and less affected by balance issues.

Eye-Hand Coordination
Space not perceived by the visually impaired person will be given priority in stimulation work. The aim is to train the patient to explore the unseen zone by scanning space with the gaze in an organised way, i.e. by multiplying voluntary, intentional and anticipated saccadic movements. For example, in the test illustrated in figure 44, the patient is asked to look for certain dominoes deliberately located in the area not seen. The very fact of adding a body movement at the end of the saccadic eye movement allows it to be confirmed that the visual strategy has been adapted to well.

Figure 44: *Example of an eye-hand coordination test:*

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The requested dominoes are located in the area not seen.

Discrimination
Scanning work in the missing field of vision is done using deliberate saccades on isolated targets for greater ease and then on more complex tasks. The test shown in figure 45 a) demonstrates the importance of good organisation of ocular movements, in order to be able to find detail, here the cow, in this complex scene.
The visual span – number of letters seen in a single fixation – is reduced in impairment of peripheral vision. The eye-hand and eye-head strategies previously improved through exercises are then brought into play when reading. For this, computer training software is available and allows work with random appearance stimulations (figure 45 b).

Figure 45: *Examples of discrimination exercises:*

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a) Search for an unusual object (the cow in the street).

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b) Discrimination exercises on the computer screen: smaller and smaller or less and less contrasted figures appear at random.

Endurance and Effectiveness
All visually impaired people, whatever the type of condition affecting them, wish to succeed in carrying out their favourite activities for the maximum amount of time and with the least fatigue possible. To achieve and develop the necessary performance, training exercises are practised daily at home, with a regular increase in their duration. The difficulties encountered (visual fatigue, errors when moving to the next line when reading, slowness in identifying things in a shop etc.) are evaluated and commented on regularly. They serve as a starting point for further development.

The development of the residual functional vision allows the visually impaired person to «perceive better» in order to "see better" in all situations. This work enables the person to use their vision in an "alternative" way, to the best of their capabilities. The visually impaired person is aware of greater efficiency in doing everyday tasks and thus has new confidence in what they see. It is the acquisition of this precision in the use of the visual function that allows good adaptation to magnifying optical systems.

c) In Cases of Overall Vision Loss

Conditions causing loss of the overall vision often leave people extremely handicapped and greatly deprived, given the significance of the physiological disruption caused.
For these patients, it is most often a question of social, family or even workplace re-integration. The compensations to be developed can be based on touch, hearing, smell and taste. A more global treatment is then necessary with several different parties involved, such as an occupational therapist, mobility trainer, trainer in daily living activities, but also the psychologist or the social worker.

C The Choice of Vision Aid

Vision aids are usually brought into use as the patient's rehabilitation proceeds. During the interview, problems and difficulties encountered are expressed but also those activities that the person would like to take up again or hold on to. However, it is not without value to re-visit these various aspects when determining the vision aid(s) necessary, since problems and wishes can evolve as the person "re-learns" to use their vision better and realises that they still have undeniable possibilities.
It is essential to detail the difficulties encountered by the patient indoors and outdoors and how they adapt to the various situations encountered. It is essential to get them to express, on this occasion, what help they expect.
Active listening by the practitioner is essential, in order that the person expresses him/herself and makes known their real aspirations. The empathy achieved on this occasion will allow areas to be detailed where it will be possible to provide an aid but also those where it will not. Thanks to the large number of vision aids available today, numerous solutions for all sorts of activities can be found (to the exclusion of driving a car, which remains beyond what is legally possible in most countries).

1. Evaluation of the Project

No vision aid can give back the previously normal sight, or provide assistance in all circumstances like a pair of spectacles compensating for ametropia. It is therefore very important to determine with the visually impaired person, and taking the greatest of care, the actions they wish to be able to accomplish as a priority, since each activity imposes its constraints and the vision aid sought must be able to respond to them.
There are many different activities concerned:

- living space: this will be the case with demands for adaptation to the environment in which the person lives.
- distance vision: recognising a person, identifying or navigating in the street and watching television are common requests.
- near vision: these are the main requests from elderly people who do not go out much and perform sedentary activities such as reading, writing, knitting or embroidery, cooking, board games such as Scrabble®, playing cards, etc.

Figure 46: *Living space:*

When the plan(s) has/have been expressed and selected,

Three parameters must be defined to characterise the relevant aid :
- What is the working or observation distance?
- What is the visual acuity required to accomplish the task?
- What are the contrast conditions for this activity?

An assessment of the working or observation distance is made by asking the question to find out whether the project requires a set distance or whether it can be varied without any particular difficulty other than the development of new habits relating to posture.
It is usually recognised that the visual acuity required to perform domestic tasks is approximately 20/100 (6/30), 20/60 (6/18) for writing and 20/30 (6/9) for reading, although some reading of very fine or low contrast characters requires 20/25 (6/7.5). In all other cases, we proceed by comparing with low vision reading tests, in order to assess the order of magnitude of the acuity necessary.
Finally, the contrast required by the chosen activity is most of the time assessed subjectively and compared to the patient's contrast sensitivity values measured during the sight test described in section 4 A 2f).
With this information established, it remains to assess the theoretical magnification but also the type of aid most suited to the chosen activities.

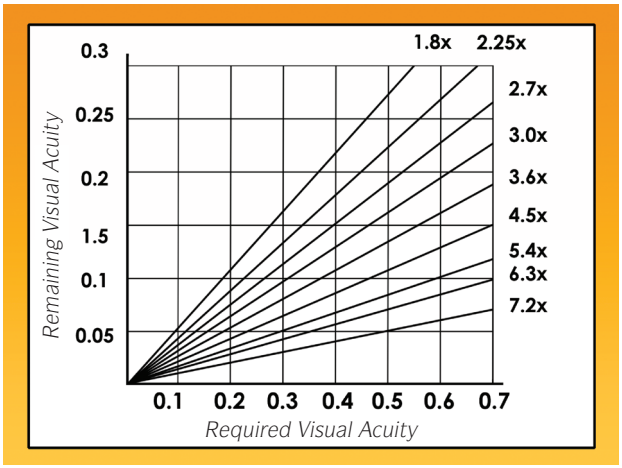
2. Assessment of the Magnification for Distance Vision

The optimized visual acuity, measured with the correction in place (found according to the methods described in section 4 A), will allow the determination of the theoretical magnification provided by the vision aids necessary for the desired activities.
Thus, this magnification is given by the following ratio:

Magnification = Required Acuity / Remaining Acuity

We can determine this magnification by a simple calculation or by using the table shown in figure 47.

Figure 47: *Determination of the magnification needed:*



The X-axis gives the required acuity imposed by the project and the Y-axis the patient's remaining acuity optimised after refraction. The magnifications are read on the oblique lines that pass through the points determined by the two preceding values.

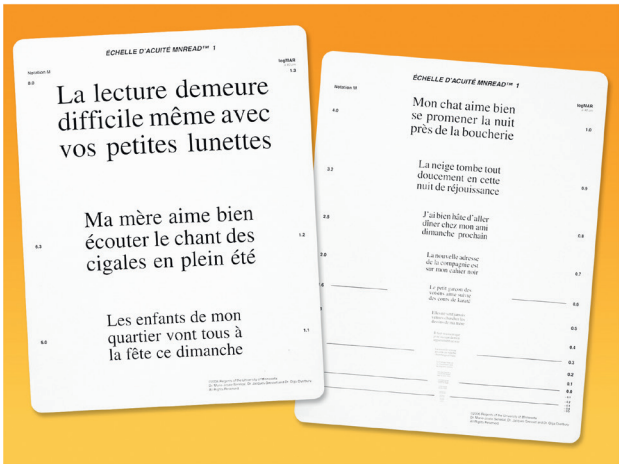
3. Analysis of Near Vision

Near vision is usually assessed using specific tests for visually impaired people. There are numerous models that give quick results but it can also be done using any customary near vision test.

The test, suitably lit, is placed at the observation distance required by design: the patient, wearing their distance-vision correction and with the addition required for reading at the desired distance, reads the text. Depending on the size of the smallest characters that the patient can read without error, the theoretical magnification - required to read either the reference text, usually similar to the characters in a newspaper or to see items whose size will have been assessed by comparison – can be determined.

For example, an assessment of the theoretical magnification necessary to read a newspaper, established using the test described below, is conducted as follows: the test is positioned 40 cm away and suitably lit. The person is given a +2.50 D lens (accommodation effort required to read at 40 cm) added to their far-vision prescription. They are asked to read the smallest text they can. If, for example they can read the group of words with a character size of M 2.5 and can no longer read, or only with difficulty, the next group of words and the newspaper to be read contains letters whose size is M1, the necessary magnification is assessed by the ratio 2.5:1, i.e. a magnification of 2.5x for a distance of 40 cm.

Figure 48: *MNREAD reading capability test (french version):*



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Doctor Parinaud's Magnification Test Assessment

Doctor Parinaud's near-vision charts are commonly used in French speaking countries to measure the reading ability of patients with normal vision. Graduations P8, P10 (for Parinaud 8, Parinaud 10 etc.) and so on in bold characters can be used to test the visual capabilities of visually impaired patients, although it is not the most appropriate test, due to the limited number of words included at these levels. Note that Parinaud's P notation correspond to half of the N size notation in print sizes, which is used in many countries.
To assess the magnification necessary for reading, the patient's correction is placed in the trial frame, to which is added a +3.00 D lens corresponding to the accommodation effort brought into play by reading the test, which the patient is made to place 33 cm from their eyes (or a +2.50 D lens for a 40 cm reading distance). The patient is then asked to read the smallest characters that they can decipher.

Knowing the Parinaud (or N) number read, estimation of the required magnification for reading can be made according to the following table:

Parinaud Notation	*P3*	*P4*	*P5*	*P6*	*P8*	*P10*	*P14*	*P20*	*P28*
N Notation	*N6*	*N8*	*N10*	*N12*	*N16*	*N20*	*N28*	*N40*	*N56*
Decimal near-vision acuity (at 33 cm)	*0,6*	*0,5*	*0,35*	*0,3*	*0,25*	*0,2*	*0,13*	*0,10*	*0,06*
Decimal near-vision acuity (at 40 cm)	*0,5*	*0,4*	*0,3*	*0,25*	*0,2*	*0,16*	*0,11*	*0,08*	*0,05*
Magnification required for reading	*1,0x*	*1,2x*	*1,5x*	*2,0x*	*2,5x*	*3,0x*	*4,5x*	*6x*	*10x*

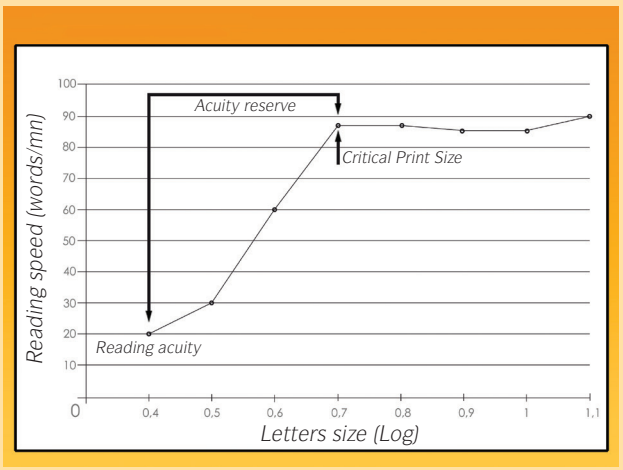
The MNREAD Reading Capability Assessment Test

Created at Minnesota University, the MNREAD Acuity Chart is a standardised reading chart for the visually impaired that allows the simultaneous measurement of the reading speed and near vision reading acuity. The MNREAD scale comprises 19 short sentences with dimensions varying between 1.3 logMAR and -0.5 logMAR. The progression step is 0.1 logMAR, allowing a precise assessment of reading acuity, whatever the visual acuity range. Each sentence is made up of the same number of words and spaces. The type of words is chosen from a semantically controlled lexical base.
This standardised visual acuity chart allows three important items of data to be obtained:

- **the maximum reading speed,** i.e. the highest reading speed obtained where the size of the characters does not influence reading speed.
- **reading acuity**, i.e. the smallest character that the person can read without making errors.
- **critical print size** (CPS for Critical Print Size), i.e. the smallest size of print that the person can read at an optimum reading speed.

The size of the letters recommended for optimum reading is situated between the reading acuity and the CPS, an area called the reserve acuity. This reserve acuity is specific to each patient and reveals the reader's endurance latitude. To ensure comfort and optimum reading endurance, it is recommended that the reading acuity modify by + 0.3 log (i.e. three lines higher than the reading acuity) to be the reference acuity for calculating the first magnification choice of the vision aid.

Figure 49: *MNREAD reading capability assessment test for the visually impaired:*



*SENECAL MJ, GRESSET J, OVERBURY O. «Version française du Minnesota Reading Test». *L'incapacité visuelle et la réadaptation : volume V.*, Université de Montréal, Montréal, 2003: 31-34.

4. Tests and Recommendation

This stage is delicate since it is eagerly awaited by the visually impaired person, who secretly hopes to regain the sight that they had previously with spectacles. There can be lot of emotion present when doing these tests and all the professional's know-how and intuition, experience and the reciprocal trust that has been developed since the start of the examination, are essential for them to go well.

Visually impaired people are appreciative if the tests are conducted in a real situation, on a table "like at home" on a normal chair away from special installations, in order to be in the most familiar environment possible.
Tests are conducted using "real" magazines, newspapers and other items from everyday life, since that is exactly where we are, in the phase of helping with tasks of everyday life.

Figure 50: *Demonstration set up:*

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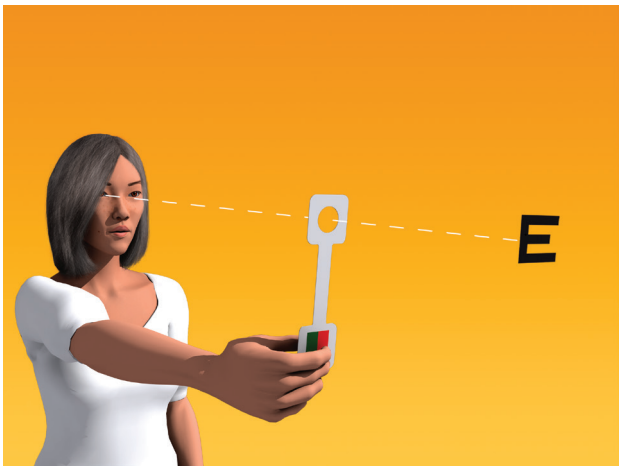
The determination of the objective, during the preliminary interview, provides information on the required acuity, the viewing distance required and any need for an improvement in contrast. These elements will allow the practitioner to select various aids. For this, he/she can delve into the wide range of systems available, the different families presented in chapter 3, and select those that satisfy the various parameters mentioned above.

Typical example
Consider a person whose acuity is 20/200 (6/60) and who wishes to read the newspaper for which the necessary acuity is assessed as being 20/25 (6/7.5): he/she will need an 8x magnification system. Among the 8x magnification systems that can be offered are magnifiers, a Galilean system, a Kepler system or an electronic magnifier. Since the newspaper reading distance can be easily adjusted, only the patient's comfort and their opinion during the test will allow a choice to be made between the various options. Also, reading black letters on a white background provides a satisfactory contrast, even if, in the case of daily newspapers, it is often less than perfect; the possibility of improving it by interposing tinted filters during the various tests can nevertheless be considered.
If that same person also wants to play Scrabble®, their equipment may need to be different. Their available visual acuity is still 20/200 (6/60) but the acuity necessary for this activity is now only approximately 20/100 (6/30); the magnification necessary is no more than 2x. The contrast on the tiles is excellent, since the letters are indeed black on a white background. On the other hand, the observation distance is a greater constraint. While the player can look more closely at the rack on which the Scrabble® letters are arranged, they have to look at the playing board from a distance of approximately 50 cm. Systems that do not allow this distance – magnifier, microscopic system, electronic magnifiers and enlargers – therefore have to be excluded. In that case, tests are conducted using Galilean intermediate vision systems and Kepler systems

a) Which Eye to Correct?

When the necessary magnifications is low (3x maximum), we try first binocular correction, which provides greater visual comfort to the patient. On the other hand, when magnification is greater, working distances are very short and make binocular vision impossible; we then use a monocular correction.
When the acuity in each eye is very different, 20/100 (6/30) for one eye and 20/400 (6/60) for the other, for example, there is no ambiguity: the better eye must be corrected. On the other hand, when the visual acuity in each eye is similar or close, it is necessary to determine which eye is the more suitable for each situation. For close vision, it is usually preferable to correct the dominant eye, due to the relationship that exists between the eye and the hand. This has usually been determined during the vision assessment.

Figure 51: *Search for ocular dominance and hand/eye correspondence:*



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In the example, the patient is right-handed and the dominant eye is the right one.

b) Testing Various Systems in Situ

Once the systems have been selected, the Low Vision Specialist presents them to the patient one at a time, while explaining them and giving information about their use: adjusting the observation distance, appreciation of the depth of field, lighting adjustment, moving the document, etc.
Initially, the professional takes control of certain parameters such as lighting, which they adjust themselves, or the movement of the text for example, since, at this stage, the important thing is to determine the aid with which the visually impaired person will be most effective and will feel most comfortable.
Once the choice has been made, the best way to learn how to use the vision aid can be explained, in order that it can provide every possible advantage, so that the visually impaired person can function independently.

5. Learning to Use Optical Aids

This stage is extremely important. For a vision aid to be used and to be of value, it is fundamental to teach the person how to use it, in the way that they would for any appliance that they have just purchased, by reading the instructions for its use. The visually impaired person must master the aid, in order to adopt and use it as naturally as possible in all situations.

a) Lighting Adjustment

The importance of good lighting has already been mentioned for everyday activities such as close-up activities requiring precise vision. Throughout the rehabilitation process, this aspect should be detailed and explained. This stage consists of learning to adjust and direct the beam of light. For example, for reading, the light beam must be directed at 45° in relation to the text plane, in order not to dazzle but also in order to avoid glare or shaded areas on the text.

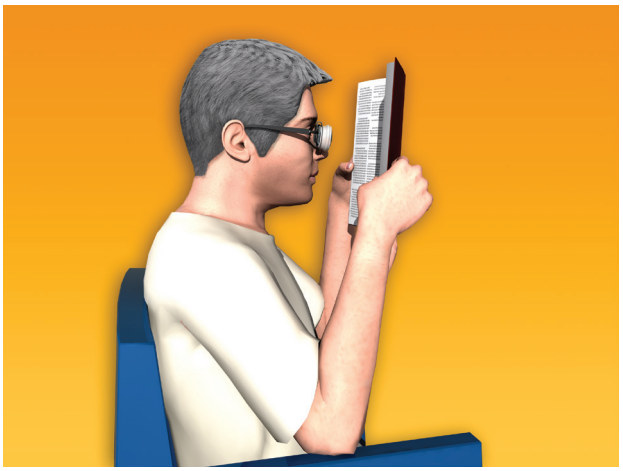
Figure 52: *Example of a good installation:*

Note that the lamp is installed on the opposite side of the hand, so as not to create shadows; the lampshade is adjusted so as not to dazzle the patient.

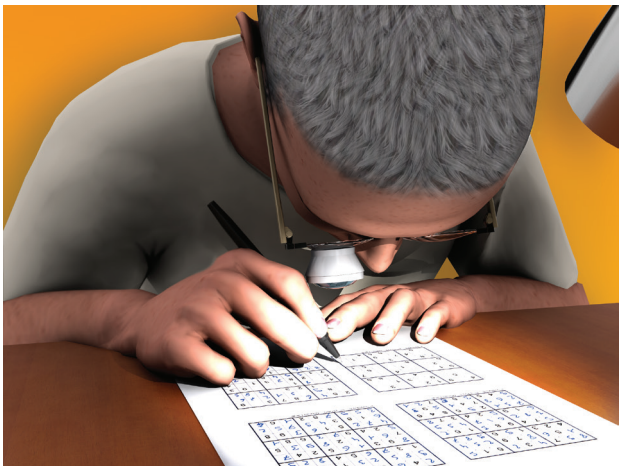
b) Maintaining Working Distance

Optical magnifying systems impose a working distance that depends on their magnification and on the person's depths of field, which can be very narrow or non-existent for the elderly. In order to achieve stability, the person is advised to sit at a table, on a height-adjustable seat, so that they can comfortably put their elbows on the table. They can then hold the text in their hands with their elbows bent, to adjust the reading distance. To reduce fatigue, it is usually recommended that the document be placed on an inclined reading stand facing the person and placed on the table.

Figure 53: *Keeping control of the working distance:*



a) Reading: the elbows are placed on the armrests for greater stability.



b) Writing: it is important to adjust the height of the chair. Installing the document on a desk can produce a more comfortable position.

c) Mastering the Movement of the Text

Since the depth of field of vision aids is extremely low, the focusing distance must be fixed. To do this, the person must learn to keep the head still in a comfortable position and to move the document to be read sideways and parallel to the plane of the eyes.

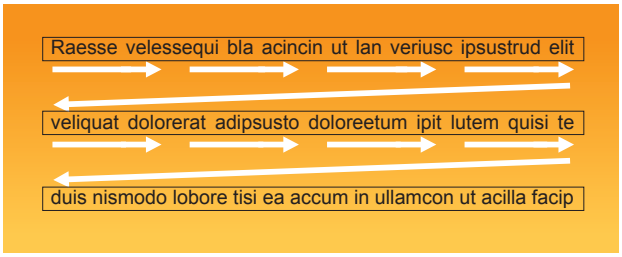
Figure 54: *Mastering moving the text:*

The person has their elbows and forearms positioned on the table, in order to be able to move the book parallel to their face as they read.

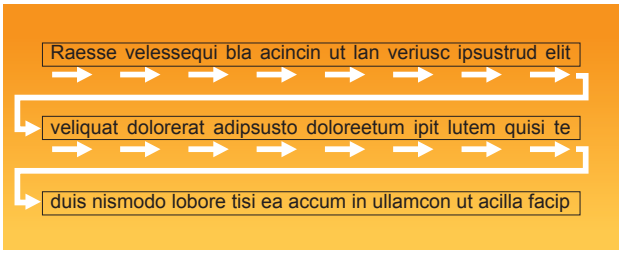
d) Mastering the Returns to the next Line

Since the field of view perceived through optical systems is usually narrow, it is difficult for visually impaired patients to locate themselves on the page: they often "skip" lines since their peripheral retina cannot assist them in identifying the next line. It is therefore necessary for them to go back along the line they have just read, like old fashioned typewriters, before going to the next line. This mechanism must be practised, in order for speed to be acquired. Mastery is only obtained through constant repetition and practice until it becomes completely natural.

Figure 55: *Mastering the return to the next line:*



a) Moving to the next line for a normal reader: the peripheral retina allows the beginning of the next line to be identified without error.



b) Moving to the next line for a visually impaired person equipped with an optical or electronic system.

6. Making Customised Optical Vision Aids

When the vision aid has been selected and when its use has been learnt, comes the time to produce the customised aid for the subject.

a) Taking Measurements

It is extremely important that measurements are precise, given the strong power of the lenses and optical systems proposed. Also, in the case of the adaptation of Galilean or Kepler telescopic systems, it is imperative that the patient's visual axis corresponds perfectly to the system's optical axis, otherwise there will be a significant reduction in the field of vision perceived through the instrument.

The *pupillary distance* recorded is the one measured in distance vision. In some cases, and quite particularly in the presence of a central scotoma, it cannot be measured using a corneal reflection pupillometer, since the patient fixates poorly and sometimes even finds themselves dazzled by the target to be observed.

The technique most often used in Low Vision is known as the "Viktorin" method, illustrated in figure 56. The patient wears the chosen frame, suitably adjusted, and looks straight ahead. The practitioner positions him/herself directly in front of the patient and at eye level, masks the subject's left eye and asks the patient, using the right eye to fix the practitioner's left eye and then marks the centre of the pupil of the right eye. They then do the reverse operation by masking the right eye, asking the patient to fix the practitioner's right eye, in order to mark the centre of the pupil in the left eye. The practitioner can thus read the pupillary distance in distance vision and the height in the primary gaze position. We should note that when a visually impaired person has difficulty fixating due to a major scotoma, a pentorch is used, which is easier to identify.

Figure 56: *Taking measurements, using the Viktorin method.*

The vertex distance is a piece of information that must be taken into consideration mainly with Kepler systems, so that the exit pupil of the instrument corresponds as closely as possible with the eye's entrance pupil. If this is not the case, the field perceived through the device is considerably reduced. Generally, telescopic systems are constructed assuming a vertex distance of 12 mm.

Entrance Pupil, Exit Pupil

The eye's entrance pupil is the image of the actual pupil, that is positioned between the cornea and the lens, as viewed through the cornea. It governs the chief ray of the light beam entering the eye. *The exit pupil* in an optical system is the image of the entrance pupil considered from the back of the system. It governs the chief ray of the light beam exiting the device.

When the eye's entrance pupil coincides exactly with a device's exit pupil, all the light exiting the device enters the eye, which can then benefit from the maximum amount of light transmitted and from the maximum field of view. When this is not the case, the field perceived through the system reduces exponentially and the wearer suffers from a reduced field of view.

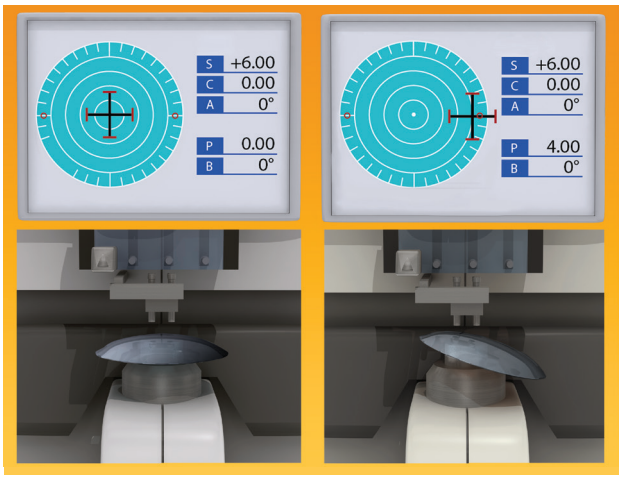
b) Fitting Advice

Monocular microscopic systems are usually centred for the distance PD and positioned on a line at the so-called "boxing" height (half-way up the height of the frame).

Binocular microscopic systems, which can be produced up to approximately +12.00 D, are also centred for the distance PD with the addition of the necessary prismatic effect, either by a prism ordered as a special manufacture, or by decentering the lens.

For example
for an addition of +6.00 to be placed in a frame, whose size is 44 - 18 and an emmetropic patient with a distance PD of 62 mm, the diameter to be ordered, in order to be able to make the necessary decentration for the wearer's visual comfort (i.e. 10 mm, see Section 3 D) is given by the simple formula: diameter to be ordered = usable diameter + 2 x decentration; so for usable diameter of 45 mm: 45 + (10 x 2) i.e. 65 mm. Surfacing of the prism is required if the necessary diameter is not manufactured in the desired power. The importance of not choosing frames that are too large when producing these binocular systems must be stressed.

Figure 57: *Fitting a pair of prismatic spectacles (4Δ prism).*

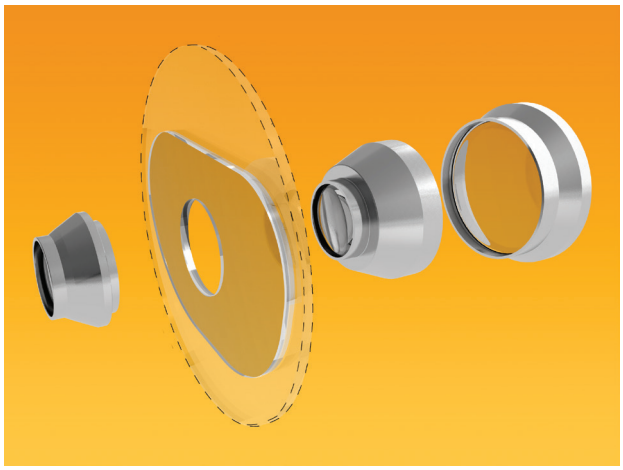


As stated previously, it is imperative for monocular telescopic systems that the visual axis for the corrected eye corresponds to the system's optical axis. For this, it is necessary to place its optical centre in coincidence with the distance visual point, the point where the patient's visual axis intercepts the lens in the gaze's primary position. The vertex distance must be as close as possible to the 12 mm assumed in construction.
For telescopic systems intended for use in distance vision, height centring is done in correspondence with the primary position of the gaze. When they are intended for use in near vision, the optical axis of the telescope should coincide with the visual axis in near vision and the system decentred accordingly. For example, if the frame has a pantoscopic tilt angle of 8°, then the system should be lowered by 4 mm.

Although the use of *binocular telescopic systems* is relatively rare, everything that has just been said on the subject of monocular telescopic systems remains valid. The particular feature of these fittings resides in the adjustment of the convergence of the optical axes, so as to provide the patient with a perfect overlapping of the right eye and left eye fields of view. The horizontal decentration of the eye-pieces corresponds with the distance vision PD and the working distance. These arrangements should only be proposed when the patient has good convergence.

The fitting itself, i.e. the positioning of the system on the pair of spectacles, depends on the model. It would be too tiresome to list all the possibilities here; they are described perfectly well in the supplier's catalogue. It must be stressed, however, that it is necessary to always think of adding the patient's optical prescription to these different systems: it is the essential condition for the image to be focused on the retina and in order for the system, whatever it is, not to magnify blurred images.

Figure 58: *Fitting principle for a Galilean system.*



Finally, the frame that is used to support the optical system must be solid, equipped with a wide stable and comfortable bridge and have flexible hinges, so that the face of the glasses does not get distorted during handling. Strong, thick metal frames are most particularly recommended, since they are easier to adjust and last better over time than plastic frames.

c) What to Fit to the Other Eye ?

When the patient is not fitted with a binocular device, the question arises of what to fit to the non-corrected eye. Here again, it is necessary to look at what best suits the person's visual comfort.
If the acuity of this eye is very weak, it is often sufficient to propose an optical correction, in order for the patient to benefit from global orientation vision with this eye. On the other hand, in cases where it is the dominant sensory eye, it can cause interference with the image in the equipped eye. Vision with the system is then less good than if it were occluded. However, it is not recommended to occlude it off completely but partially occlude it with translucent film stuck to the back of the corrective lens, in order to maintain an active peripheral perception activity for this eye.

Figure 59: *A few examples of occluding the uncorrected eye.*

When this eye is not the dominant one, it can be a good idea to have a lens with a slight magnification added to the correction, in order to provide the patient with alternative vision: one eye for precise vision through a magnifying system and one eye for global vision through the spectacle lens. Note that this is only possible after complete rehabilitation but is very useful for people who have adopted this way of working with their sight.

d) Delivery and Adjustment

Adjusting the frame plays an essential role in the adaptation and ease of use of microscopic and telescopic systems. To be given particular consideration are:

- *The vertex distance for* Galilean and Kepler systems;
- *The inclination and curvature* of the frame for all systems, in order that the eye quickly finds its field and the visual axis corresponds exactly with the system axis;
- *The nasal fitting* of the frame, which must be stable and correspond well to the patient's morphology;
- *The length of the sides,* which must allow good adjustment, so that the frame is held properly in place.

Finally, some *maintenance advice* should be offered:
Systems should be dry cleaned using a micro-fibre lens tissue provided for the purpose, so as not to scratch them: the use of water, alcohol or any other solvent is expressly prohibited.

In concluding this chapter, it should be remembered that several systems are often necessary to manage the visually impaired person's various activities or working distances. It is important to offer only one system at a time and to wait until the person is using the first system correctly before introducing another one.

Supplement

Summary on the Choice of Optimum Vision Aid

The optimum vision aid is the compromise that best manages to meet all the criteria associated with:
- The person themselves and their residual visual function
- The visually impaired person's activity or life plan
- The constraints specific to each vision aid

1. Constraints Associated with the Person Themselves and Their Vision

- Their visual acuity and reading capability
  - *This information allows the required level of the magnification of the device to be assessed*
- Their perception of contrast
  - *Provides information on the necessity to brighten the image to optimise performance*
- Their binocular vision
  - *Guides the choice of unit towards mono or binocular*
  - *Indicates the dominant eye and provides information on the eye to be corrected.*
- Their visual field and the position of any scotomas
  - *Gives information on the types of device to use*
  - *Gives information on the person's visual span*
- Their motility and fixation (stability of eccentric fixation, smooth pursuit or saccades)
  - *-Gives information on the types of device to favour (large field, lighting etc.)*
  - *Allows planning for ease of use of the aids. The more developed it is, the easier manipulations are.*
- Stability and strength of the hand, ability to grasp
  - *Guides us in adapting fitted or hand-held systems*
  - *Ergonomics of the most developed systems, such as the position of magnification adjustment buttons etc*
- Required endurance:
  - *Gives guidance on the type of aid: magnifier for occasional assistance or enlarger for prolonged reading, for example*
- Ergonomics, comfort
  - *Learning essential in line with the person's optimised functional vision*
  - *Tolerance to the various constraints caused by visual aids.*
- Aesthetics and budget

2. Constraints relating to the activity or life plan

- Activity distance; far, intermediate and near vision
  - *Type of product and its adaptation*
- Depth of field, of focus
  - *Type of product*
- Residual functional vision for carrying out the activity
  - *What magnification to use*
- What is the quality of contrast of the task
  - *Type of product*
- Is the activity carried out indoors or outdoors?
  - *Adaptation of the environment or the vision aid*

3. Constraints relating to vision aids

Vision aids cannot always meet all the criteria associated with tasks and the patient's sensory/motor profile, since these have their own constraints.

- Possible magnification
- Field of view through the visual aid
- Possibility of improving contrast or not
- Requires electrical power or not
- Focusing distance
- Size of the aid (transportable or not)
- Price and aesthetics

5. Some Examples of Patients Rehabilitation

1. Mrs N

Mrs N, aged 75, suffers from bilateral AMD, previously wet but which has now become scarring. She has no other ocular conditions. She is in good general health.
A retired accountant, she lived alone in a flat in Paris, until her other eye was affected. Her daughter, who lives in the Paris suburbs, takes her depressed and very anxious mother into her home.

The aspiration expressed by Mrs N is to get back her previous independence with regard to her administrative and financial affairs. Mrs N is emmetropic and has only one pair of single-vision glasses for near vision with a power of +3.00 in both eyes

At the fixation and eye movements assessment Mrs N is right-handed with a dominant right eye. The quality of the combined motricity is disturbed by the loss of macular fixation; smooth pursuits are impossible and saccades are very inaccurate.

At the sight test: the measure of visual acuity established at one metre with an ETDRS chart indicates 20/320 (6/95) for the right eye and 20/125 (6/38) for the left eye.

The functional assessment reveals:
- A reading ability of: right eye = N32 (Parinaud 16), left eye = N16 (Parinaud 8)
- A reading speed of 15 words a minute for N16 (Parinaud 8) size characters
- Repeatable eye-hand coordination errors.

Rehabilitation:
The first rehabilitation objective is to find and anchor an eccentric fixation. To use this para-central fixation automatically, it will be necessary to stabilise it in smooth pursuit and saccades.
Reorganising movements around this new fixation zone is the next step. When the movement is consistent with the new fixation method, discrimination, which at the start of the rehabilitation was possible for N16 (Parinaud 8) characters, is now possible with N10 (Parinaud size 5) characters.

A technical aid useful for reading administrative documents is assessed and tried. The various systems (magnifier, magnifying lenses, telescopic system and electronic magnifier) allowing the necessary magnification, judged to be 6x, are tried and compared. Mrs N's choice is a Galilean system which gives her the best image quality while maintaining a reading distance which she is happy to accept. It is loaned to her for two months. During this period, she learns to control her reading distance, maintaining focus and directing fluorescent lighting with a colour temperature of 6500 K on to the text. Reading exercises and training allow Mrs N to get back a reading speed of 95 words a minute for N10 (Parinaud 5) size characters. Now she can write cheques and check bank statements. She decides to purchase the loaned near vision system which had helped her to win back her administrative independence.

The rediscovered independence gives her encouragement and leads her to make other requests:
- In intermediate vision: the ability to read price labels in shops, which is resolved by the use of a small illuminated magnifier with 6x magnification.
- In far vision: Mrs N wishes to travel and therefore to read destination boards at the end of platforms in railway stations. A Kepler telescopic system with 6x magnification is adopted. Several weeks are required to work on organising the movement of a right-handed person with a dominant right eye: she must preferably use the left hand to position the monocular in front of the left eye, the eye with the best central vision.

Now, Mrs N has recovered her independence and left her daughter's home to go back to an apartment on her own. She uses all her vision aids appropriately: they have been adopted gradually over a period of 14 months.

2. Sophie P

Sophie is a 14-year-old adolescent, suffering from Stargardt's disease which appeared at the age of 10, during her second year of middle school (year 5). Her distance vision is very blurred to the point where she can see neither the blackboard nor the television. She is not aware of any scotoma; she sees a uniform blur. She can read up close but tires very quickly; she can only read for about ten minutes at a time. She is in good general health and is a good student. She is in her fourth year (year 9) at the local secondary school and, until now, she has had no problems with her studies, since she has not had a lot of homework. Since she has been in the fourth year, the amount of homework has increased significantly and she struggles to do it all.

Her project is to win back a measure of comfort for her class assignments by extending her reading endurance and, if possible, to improve her vision so that she can watch television.

The equipment she has: she has no special equipment. She wore glasses when she was younger but says that she no longer needs them. She does not use any vision aid.

At the sight test her acuities without correction, measured using an ETDRS chart at 4 m, were 20/200 (6/60) in each eye; there is a small improvement in binocular vision. Refraction indicates -2.00 for the right eye and -1.75 for the left eye and gives 20/40 (6/12) for each eye and also in binocular vision. She has no particular sensitivity to light.

The binocular assessment shows a slight exophoria with a limited fusional reserve, which might in part explain the visual fatigue mentioned. At the eye movement examination, smooth pursuit and saccades were fluid but out of synchronisation when the stimulus was increased.

The functional assessment indicated a smooth reading of N6 (Parinaud 3) in both eyes and a reading speed of 95 words/min in binocular vision that reduces with time.

The rehabilitation consisted firstly of showing her the contribution that could be made by correcting her myopia, both for looking at the blackboard and for watching television. This compensation was introduced without delay and greatly improved her ability to read the blackboard.

Technical aids: for her near vision, a 2x microscopic system allowed Sophie to get back to a normal reading speed and a completely adequate reading endurance for her to do her homework and read one library book each week. After several months, she is wearing contact lenses to correct her myopia and has an high addition of +8.00 in both eyes fitted to a small pair of spectacles which she wears during school activities and for near vision work. Visual training has allowed Sophie to learn to find the right reading distance with her microscopic system spontaneously and to do so in just a few weeks. The rehabilitation of her fusional reserves and adaptation to the microscopic system allows her to read with a speed of 160 words/min and to experience much less tiredness during long periods of work.

3. Mr B

Mr B, aged 47, is a baker. He suffers from alcohol- and tobacco-related optic neuropathies and can no longer work at his job. He does not receive any particular treatment and says that he is otherwise in good health.

His requirement: to be able to deal with administrative documents which he has not been able to do for some time. He is threatened with being placed under a legal supervision order, since he has not paid his bills or filled in certain forms on time. Also, he wants to be able to read documents given to him during a job training course which he will start soon as part of a re-training programme which he is taking due to his deficient eyesight.

Equipment he has: Mr B has a pair of spectacles for close work and a small magnifier that he found among his father's things, but "it doesn't help". This magnifier has a power of +9.00 dioptres.

At the sight test:
- Right eye = +4.00 / -1.75 x 35 , visual acuity 20/300 (4/60)
- Left eye = +5.00 / -2.00 x 55 , visual acuity 20/300 (4/60)
- Addition : +1,75 D
- Effective binocular vision

This man is extremely depressed and cries a lot during the initial examination.

The fixation and eye movements assessment reveal a very disturbed ocular motility. Central fixation is no longer possible and eccentric fixation is not stable, smooth pursuit movements are impossible, saccades are difficult to initiate due to the scotoma and the end-point of saccades is inaccurate due to the loss of central fixation.

At the functional assessment, it appears that the eye-hand coordination is inaccurate: reading speed cannot be determined and endurance is difficult to assess.

Rehabilitation: firstly, a meeting with a psychologist was scheduled and also the assistance of a mobility instructor, which enabled Mr B to attend various low vision appointments alone and independently (learning the best itinerary necessary, taking the bus to the town centre, etc.)

Visual training: the work allowed a new zone of fixation to be anchored and stabilised and then for harmonious eye movements to be put back in place. Eye-hand coordination was reorganised around this substitute fixation and allowed Mr B to use his magnifier with a non-central but stable fixation. The search for the stabilisation of the eye-magnifier and magnifier-paper distance was set up using fine discrimination exercises. Visual memory work was done in parallel with the work with the mobility instructor.

Technical aids: an illuminated stand magnifier with a magnification of 10x was quickly purchased by Mr B, who needed it to start his training.
An electronic magnifier was purchased later for his new office work to manage his administrative papers, read brochures, etc.

Following the adoption of the rehabilitation programme, Mr B was able to avoid being placed under a legal supervision order and to go back to work, which allowed him to "get his life back", as he put it.

4. Mrs H

This patient, a regular client of the practice with no particular history, came to have a pair of varifocals made, following a recent prescription. Upon delivery, during the reading test, Mrs H burst into tears and, turning to her husband, said: "So, you see, it's no better at all."
During the interview conducted immediately afterwards, the client explained that she had been having difficulty reading for several months and had consulted her eye specialist, in order to change her spectacles. He had noticed nothing in particular, had agreed to increase her addition for near vision and had planned to see her again in six months. This person, aged 62, is a retired French teacher and occupies herself by teaching reading skills. She enjoys this a great deal but started to have problems when having to look at a document placed in front of her on the table. On the other hand, she said that she could see people all around the table clearly. Also, when reading at home, Mrs H noticed that she needed more light and that she tired more quickly than before. She is an avid reader.

Her requirement: to be able to look at a document while maintaining eye contact with people around the table and, if possible, to be able to read for longer at home without becoming too tired.

At the sight test, for distance vision, we found the same result as the prescription, i.e. Right eye = -2.00 / -1.50 x 15 for an acuity of 20/30 (6/9) and left eye = -1.75 / -1.75 x 170 for an acuity of 20/25 (6/7.5), binocular acuity being 20/25+2 (6/7.5+2).

The optomotor assessment was completely normal.

Functional assessment: the reading speed remains good and eye-hand coordination as well. The reading ability with its addition of +3.00 D only allows N6 (Parinaud 3) text to be read. N5 (Parinaud 2) is still possible but difficult. Stronger lighting improves performance but Mrs H. finds the light tiring.

Vision aids: an addition of +4.50 D gave Mrs H back reading comfort completely identical to that which she had always had. Delighted by this regained comfort, she quickly became accustomed to the new reading distance of between 22 and 26 cm which she spontaneously arrived at for herself. For her literacy teaching sessions, she had simply adopted a document carrier in rigid cardboard some 10 cm in height which she puts in front of her on the table and on which she places her texts, to bring them closer to her eyes, so that she can read them easily.
A pair of hemi-field (Executive) bifocal spectacles has been made; in the upper part, the lens carries the distance correction and in the lower part an addition of +4.50 D, for near vision, i.e. right eye = +2.50 / -1.50 x 15 and left eye = +2.75 / -1.75 x 170

This aid, very simple, allows Mrs H to continue her activities and to retain all her reading strategies. Quite obviously, she was strongly advised to return if there was the least deterioration in her vision without waiting for her next appointment.

5. Mrs Z

Mrs Z, aged 78, suffers from atrophic AMD, which became problematic a year ago. She has also been pseudophakic for about twelve years. She has no other known ocular disease.

Mrs Z studied law but has never practised. She has raised two children. At this time, she lives with her husband in a flat in Paris. She stopped driving a year ago and uses public transport without difficulty.
In near vision, Mrs Z wants to be able to read books and magazines with greater ease and less visual fatigue. With regard to writing, she talks about difficulties in completing administrative forms and wants to be able to continue doing crosswords, where she has difficulty in centring letters in the squares.

For intermediate vision, she has expressed no particular requirement. At distance, Mrs Z has indicated strong glare both outdoors and indoors when it is very bright, while indicating a clear need for lighting, in order to be able to do close work. She describes this as an inconsistency.

Mrs Z has two pairs of spectacles, one for distance vision, the other for near vision:

- single-vision lenses for the far vision: right eye = - 0.75 / - 0.75 x 170; left eye = - 1.00
- single vision lenses for near vision that are several years old: right eye = + 2.25 / - 0.75 x 170; left eye = + 2.00

Eye movements assessment: the endpoints of the saccades movements are random. Smooth pursuit movements are well preserved as well as the near point of convergence.

The results of the Sensory Assessment give, on the ETDRS chart at 4 metres, a visual acuity, with correction: right eye = left eye of 20/32 (6/9.5) with a lot of difficulty for acuities between 20/200 (6/60) and 20/63 (6/19). Then the reading speed for letters accelerates up to 20/32 (6/9.5). Mrs Z moves her head a great deal, complaining that the letters appear and disappear very quickly.

The functional assessment revealed a hesitant reading capability of N20 (Parinaud 10) in the right eye and the left; again, reading accelerates towards N16 (Parinaud 8) and she manages to read N8 (Parinaud 4) slowly in monocular with either eye and in binocular.
Reading speed with her near correction is 54 words/min for N10 (Parinaud 5) size characters which she describes as appearing alternately blurred and clear.
No mislocation was noted in eye-hand coordination. It is even more precise for tasks involving small sizes.

Mrs Z describes the typical symptoms of AMD with central preservation. The large characters that project on the atrophic zone have parts missing so that several saccades are required for their identification. Smaller characters, of the size of the preserved zone, are then deciphered more quickly and with less effort.
In her daily life, the patient lives permanently with rapidly alternating areas of vision which then partly disappear and which cause fluctuating vision and are tiring. The aim of rehabilitation in this particular case of AMD is to increase the speed and accuracy of saccadic movements. Managing lighting is difficult since it is necessary to learn to illuminate the work area when reading or doing odd jobs, etc. without being dazzled.

Rehabiltation programme: Mrs Z was monitored for six months with one appointment per month and exercises to be done at home. She reads N8 (Parinaud 4) size books and documents daily and without effort. Her reading speed is 140 words/min with a slight over-correction: right eye = +3.25 / -0.75 x 170 and left eye = +3.00.

The requirements expressed at the start of the assessment have all been dealt with. It is important to act quickly with patients with this type of condition, right at the start of the illness, so that they do not settle themselves in a difficult situation or in failure.

6. Mr R

Mr R, aged 82, a retired lawyer, has exudative AMD for the last four years. The right eye is untreatable. The left eye was treated with eight intravitreal injections. We can see the start of a cataract in both eyes.
In near vision, Mr R has always read a great deal and wants to start again after approximately a one-year interruption; he also wants to remain independent in the management of his financial affairs. In intermediate vision, he wants to be able to read codes on doors at dusk. In far vision, Mr R goes out alone to do his shopping or to go for a walk.

Equipment in his possession:
2 pairs of spectacles:

- single-vision distance-vision lenses: right eye = plano and left eye = +0.50 / -0.75 x 80
- single-vision lenses for near vision done for several years ago: right eye = plano and left eye = +3.50 / -0.75 x 80
- an illuminated hand magnifier with a power of +10 dioptres and tinted corrective lenses for far vision.

Eye movements assessment: the eye movement, based on the left eye, shows that it is not possible to make saccades. Smooth pursuit are disorganised.

The sight assessment indicates, on the ETDRS chart at 1 metre, a visual acuity with correction of 20/800 (6/240) for the right eye and 20/200 (6/60) with difficulty for the left eye.

The functional assessment reveals:
- a very slow N20 (Parinaud 10) reading speed in the left eye.
- The reading speed with his near vision correction cannot be measured, since it is so chaotic.
- The eye-hand coordination task highlights a constant error to the left of the object.
Mr R has AMD with a significant central scotoma.

Rehabilitation programme:
The initial period of adaptive care consists of developing and then anchoring a substitute eccentric fixation before trying a magnifying aid. This work was done over five months at a rate of one appointment per month and exercises to do at home.
Then, he was loaned a 4x Galilean magnifying system, so that he could familiarise himself with the reading distance, the returns to the line and following a line.
Four months later, Mr R is reading N4 (Parinaud 2) size characters fluidly and his reading speed is 130 words/min. He reads books and can deal with administrative papers.
Unfortunately, one year later, Mr R suffered two relapses, reducing his visual acuity in the left eye to 20/320 (6/95) on the ETDRS chart at 1 metre. His reading ability is N20 (Parinaud 10) with his Galilean system.

New work is being undertaken: the new substitute zone is further away and it is necessary to re-work the eye movements and eye-hand coordination.
At the same time, Mr R. has been supplied with a Galilean system with a magnification of 8x. It allows him to read N4 (Parinaud 2) but slowly with a reading speed which, although developed, is not satisfactory to a previously avid reader. He prefers a 6x magnification which gives him reduced discrimination but a slightly greater distance for doing crosswords and some occasional reading when travelling. At home, he uses an electronic magnifier that allows him to access all the documents he needs with magnifications of between 8 and 12x, depending on the size of the items to be seen. He uses a Kepler distance-vision system to deal with signs at railway stations and to allow him to see the details of a picture at an exhibition.

We should note that the rehabilitation programme of these patients is closely linked to the clinical development of their illness. It has to be adapted to changes in the disease and to the patient's requirements, which can change as they become more aware of their potential.

Analysis of the activity of a support service in the choice of vision aids using the method put forward in this booklet.

Population: 65% of women and 35% of men aged between 6 and 97, including 3% of children and young people, 11% of adults between 20 and 50, 15% of seniors up to 70, 57% of the elderly between 70 and 90 and 14% of those aged over 90.

Complaints: the conditions encountered and treated varied of the order of: 60% AMD, 10% glaucomas, 4% retinitis pigmentosa, 8% diabetic retinopathy, 6% of severe myopic retinopathies causing a detached retina, 3% cataracts, 3% Leber's hereditary optic neuropathy and 4% Stargardt's disease. Patients' visual acuities were between 20/800 (6/240) and 20/50 (6/15) with a distribution of 33% of acuities greater than 20/80 (6/24), 48% of acuities between 20/200 (6/60) and 20/80 (6/24), 16% of acuities lower than 20/200 (6/60) and 4% of acuities lower than 20/400 (3/60).

Equipment rates: only 3% of people were not able to be given an aid due to associated conditions (Alzheimer's disease, serious depression, hospitalisation, etc.) and 5% has abandoned the strategy protocol for reasons of affordability, discouragement etc. Therefore 92% had found and adopted a vision aid for regular use.

Satisfaction rates: among visually impaired people, 65% declared themselves perfectly satisfied with the vision aids that they use easily on a daily basis and 35% said that they were moderately satisfied, either because they found the constraints for their use annoying (observation distance, the field perceived through these systems etc.) or because the reading or working comfort was no longer "as it was before" or even because the colours in the chromatic filters "change" the colours of what they see.

Types of equipment:
The visual aids determined and adopted were:

- Optimisation of the Distance/Near correction	85%
- Tinted filters	58%
- Lamps, tabletop, reading stands	40%
- Optical systems: 75%	
• Magnifiers	29%
• Microscopic systems (mono and bino)	41%
• Telescopic systems (mono)	15%
- Electronic systems: 26%	
• Enlargers (all types)	21%
• Enlargement software	5%

The number of appointments necessary to master this equipment varied between two and six with an average of 2.7 sessions per person.

Conclusion: Thanks to visual rehabilitation, 70% said that they were better able to use their residual functional vision visual and 64% judged that their quality of life improved.

Supplement: Account by a Visually Impaired Person

An ordinary day in the life of an extraordinary visually impaired person in Paris...

"The good fairies, when they leaned over my cradle, gave me an extra little present: retinitis pigmentosa. As the years went by, it became increasingly difficult to see and it has now become a disability that I have had to adapt to in everyday life. Although very often there are no outward signs, visual impairment causes a very real disability. Imagine my vision: tunnel vision, permanently foggy, like I was watching a poorly tuned television through a fog you could cut with a knife. However, *in other respects*, life goes on. *So, follow me!*

When I get up, my vision is at its worst. I can't even see the great big clock on the wall with its large numbers, although the lighting in my kitchen is outrageously strong. I take a cup at random. If it is white, I pour black coffee into it, identify the level from the contrast and then add the milk. If the cup is black, I do it the other way round. I spread my bread with jam in preference to butter.
Every day, shaving is a real song and dance that I won't bore you with here.
Then it's time to get dressed. Of course, I could make it simpler by always dressing the same, or any old way. Not being greatly attracted by either solution, I have put in place a strategy to continue to dress myself according to my mood or meetings I have to attend, rain or fine weather. Unless garments are recognisable by some little detail, visual or tactile, I label each pullover, pair of trousers or socks with a white card, showing the colour in large black characters. Of course, that requires vision assistance and for matching colours, I rely on my good memory. The rest is child's play, or almost! I don't have to tell you that sometimes there's a hiccup, like going through the day with one red sock and one brown one!
Now it's time to go and face the big wide world and 'earn my daily bread.
Final stage before departure, if I'm not going somewhere I already know, I have to prepare my movements in detail. That's where my video-enlarger comes in, an indispensable tool for reading anything that passes between my fingers. I run the map of where I have to go during the day under the camera's lens. Then the one for the metropolitan network, that I know quite well; that helps. I identify the route to take, memorise the number of stations, their appearance and two or three letters of their name, in case I can't read them. Of course, I could ask someone; I do that sometimes, but I prefer to rely on myself. Incidentally, these intellectual gymnastics make the memory work hard and this is essential when compensating for the visual deficiency.
The moment arrives to enter the arena; that's not over-stating it. I've lived in my building for such a long time, that I have my familiar references to the point that I can walk around with my eyes closed. Things get more complicated if I run into a neighbour I can't recognise or, worse still, can't see. I adopt a very absorbed expression in the hope that the shadow will greet me first and I will be able to recognise the voice and exchange a few, let's say ... more personal words. I've been taken for stuffy more than once. Perhaps less so now that I often unfold my white stick, especially when the place is quite dark. My apparent disability is not really understood. Some people continue to pass by and ignore me and don't know how to act; others greet me and say their name... It's so difficult to understand visual impairment. Hasn't it happened to me that I stop to pick up a pin on the ground and bump into an elephant?
Once I'm in the street, the first difficulty is passing through a barrier of children and parents standing outside the school. Finally, there's only one crossroad to negotiate before I reach the station. Since I can no longer see the colours of the traffic lights and I don't trust the flow of pedestrians who often take no notice of them, it's the flow of traffic in the road that crosses mine that tells me when to cross. I have to admit here that when I use my white stick, a passer-by will often spontaneously help me, either telling me 'you can cross now' or taking me by the arm.
So why don't you always use your white stick, you ask? Because I want to hold on to the value of a strategy developed over time and be independent in my movements, especially when it comes to my job, where I have to hide my disability.
The station square is vast and with no fixed references to guide or direct you, strewn with steps and changes of level... Here a plant trough, there a concrete post that blends in with the pavement. The station, newly refurbished in glass and steel, also conceals its glass doors very well. I therefore adopt the pilot fish's strategy, i.e. I go in with someone else. And if there's no-one around? I work along the wall until a panel opens as I approach. Inside, everything is the same colour; there is no colour contrast, nothing to attract the eye. On a rainy day, I see everything as grey; when it's sunny I'm dazzled and at night, the ceiling lights merely twinkle dimly. The architects were too clever by half when it comes to accessibility. Happily, the steel ticket machines that melt perfectly into the background are not completely silent. My acute hearing can pick them out. When you are visually impaired, all your senses are alive, even your sixth sense! By trial and error I put my ticket in the machine and get it back further along, still by trial and error. Then I go down the stairs that plunge into semi-darkness; contrasting step edges would have been a great help. Only almost-daily practice stops me from breaking my neck. An aggravating factor, the handrail, which I use as a guide and which any person not sure of their footing can hold on to, is not continuous! In the middle, it is interrupted by some woven steel structure, that I still can't see the point of. On the platform, I weave between Chinese shadows here and there, scanning the space in front of me. I want to be sure that there is a clear space when I approach a display panel. Since I can't look upwards and straight in front of me at the same time, it is not unknown for me to bump into one or two people. As for reading the miniature screens hanging in the air, it is usually a waste of time; the letters are small and with little contrast and I can't make out some of the indicator lights.

When the train arrives, I try to identify where the doors are; sometimes the colour contrasts with the carriage sides, sometimes not. So I identify a passenger and fall in step with them. If I'm alone, I slide my hand quickly along the car until I find the handle. Otherwise, I have to wait for the next train. Today, I got on. By chance, the jump seats are free. I prefer them because they're close to the exit and I can easily see whether or not they're occupied. Otherwise, I remain standing close to the door. So, when it opens, I sometimes manage to recognise the station more easily, read the name and get off quickly, if it's my station.
Now I'm settled for a moment or two, I'll tell you one of my 'tricks': I always try to get on in the middle of the train which coincides with the 'alarm' display in the centre of the platform. Why? Because when the train slows down, it is from this car that I have the best chance of deciphering the name of the station, because the train has already slowed down when my car enters the station and I still have a little time before it stops to recognise the station, because, do you know? There aren't always voice announcements.
Oh dear, that was Saint-Michel, my station, that I missed because I wasn't concentrating! I'll have to brave the next one, Châtelet, and then go back on myself. That's not the easiest thing to do, a huge underpass with signs perched in all sorts of positions and any old way, either in a shadowy area or in the beam of a dazzling spotlight, when they're not hung directly over a stairway and written in small characters into the bargain and in soft colours! Woe betide the poor visually impaired person who stops to try and read one! That's when I unfold my white stick to avoid the to and fro of the crowd. And then a miracle happens at Châtelet. This sign that I'm different straight away attracts the attention of a kind fellow who offers me his help, which I accept gladly. It is so good that, in the twinkling of eye, you can put yourself in the hands of a saviour. Which exit is the right one from all those on offer? Perhaps Notre Dame? The hospital that I'm going to, to visit a colleague, is just a stone's throw from the cathedral. Arriving at a crossroads of corridors, more signs, not visible to me and not a soul in sight. A small breeze of cool air tells me that the surface can't be far away. I head in that direction.
What can I give my friend, confined to his bed after an operation on his eyes, if not an audio book? By chance, the hospital bookshop has a shelf full of them. My eye is drawn to an original title, 'Gone with the Black…' by a certain Jacques Priou. I buy it. I count my change by trial and error but not at random. In this respect, things have got somewhat better since the changeover to the euro. Each coin is recognisable by its distinctive edge. As for the notes, all the sizes are different and one side is printed with large numbers. Getting to the ophthalmology department now is child's play, since someone told me in great detail how to get there through the maze of corridors and stairways in this old building. Finding the department easily, I now have to find room 18. I press my nose to each door to decipher the number written in light grey on a beige background. When it comes to the contrast, it could have been done better! An enormous woman, who must have noticed me on this merry-go-round, took me for an eavesdropper and asked: '*Are you looking for something?*' I explain… '*It's down there*,' she says, pointing to the end of a dimly lit corridor. I explain again that I can't see very well or clearly and not very far. '*If you can't see a blind thing, then you should wear glasses, you poor old thing!*" I wasn't very surprised by that comment which I've heard a hundred times before, but for heaven's sake, coming from an ophthalmology nurse… As if it would be enough to stick a pair of glasses on someone with visual impairment and expect them to have the eyes of a cat. If it were that easy, I'd have done it long ago, wouldn't I! So, I explain. '*Follow me*,' she commanded, disappearing at high speed while I was impaling myself on a trolley that had been abandoned in the middle of the corridor. Finally, I arrive, knock on the door and go in, hearing a familiar voice, and make my way to the bed perceived by my remaining shred of retina, spreading myself on the first bed which my narrow field of vision had hidden in this room that was white from floor to ceiling.

I throw a glance at my watch with the enlarged numbers. Noon. I'm due to have lunch with a customer. Outside, the sun is shining and the sky must be blue. I put on my cap with the long peak and my RT spectacles, without which I would not be able to get around. These lenses increase contrast by filtering out harmful rays. Without them, all I would see would be white.
In the underground once again, it's the opposite phenomenon that occurs. I see only black. And when I move from light to shade, my damaged retinas take an awfully long time to adjust. So I go carefully and slowly. I analyse the least visual clue to make out the nature of the ground, the existence of corridors or stairs, the presence of any obstacles.
Kitchen smells tickle my nostrils; I'm approaching the restaurant. My customer sees me well before I notice the restaurant's name. He knows about my vision problems and comes to meet me. He walks in front of me into the room with its flickering lights and I quickly lose my sight. I wait, acting as though I'm looking for someone. He comes back, pleased with himself that he's chosen what is supposedly the best-lit table. In my heart, I hope that my retinal cells won't let me down. And to cap it all, the table cloth and serviettes are also dark. Nonetheless, I continue to put on a brave face, since I still have a trick up my sleeve that I can use now. I will choose a brightly coloured dish that I will be able to see clearly on a white plate and one that doesn't need to be cut into pieces: *chilli con carne*. Horror, even the plate is dark!

A little air will do me most good. I will walk to my office. At this time of day, the sun is behind me and lights up the buildings well without dazzling me. For a little while, I could almost forget my impaired sight. Because I often walk along this pavement, I can avoid the thousand and one obstacles strewn along it. Posts of every type, barriers, bollards and other projections intended to prevent invasion by cars, advertising boards, not to mention sales stands and terraces. The remaining pedestrian area is nibbled away by «two wheelers» and the pavements are reduced to the 'width of knife-edge' but also transformed into a 'wall the size of the Atlantic'. My mobile rings. It's Mr X, suggesting that I drop into his office just around the corner. An offer of business is not to be missed. Damn it. Where is the code entry pad? Ah, there it is. I can't see the numbers in the sun. No raised area on the 5 on the keypad. I get angry and discouraged. Actually, I have a new electronic diary! I call Mr X, stammer that I've forgotten my glasses and he releases the door catch. Where is the light switch? Where is the lift? It is waiting with the door open. I think I recognise 7 and press it. It's the alarm! I disappear and go up on foot. My host is waiting for me in the meeting room: 'Did you get lost?' he asks me when I arrive. 'I walked up; the lift is out of order,' I say absently. I sit down where the lighting is helpful to me. He hands me some documents on which he has made some comments. I pretend to read them. I make a few notes as a precaution, using my black felt pen. With the meeting over, I take my leave, satisfied. '*Aren't you forgetting something?*' asks Mr X, smiling. I have written some of my notes on the white table and not on my note pad!
This evening, I'm going to try to get home before it's dark. Twilight, it's the worst time to be in the street: familiar points of reference disappear, contours blur, contrasts are reduced. I don't take my eyes off the illuminated advertising sign at the corner of my street. I turn right and it's a haven of peace: home!
From this, you will understand that for a visually impaired person, a day takes twice as much out of you!"

Quentin Valesca

Conclusion

At the end of this tour of the rehabilitation process of visually impaired people, we hope that the techniques and concepts developed in this booklet will be of assistance to eye care professionals specialising in Low Vision in their daily practice.

Learning how to dispense the vision aids presented will, once they have been mastered, allow visually impaired people to receive quality care that will be shown to be no more time consuming than other services routinely dispensed, such as fitting contact lenses.

In addition, Low Vision practice develops in the practitioners who devote themselves to it, skills like attentive listening and customer oriented approach as well as an ability to search for customised solutions. It enriches their knowledge of the vision process and allows them to improve the quality of the service offered to all their clients and so participate in the overall growth of their practice.

The effectiveness of well structured program for visually impaired people has been proven to render a great service to these patients. An analysis of the activity of services specialising in Low Vision shows the degree to which the adaptation stage for the visually impaired person is particularly important, both for that person's function and for their morale and even for their integration into social life and their desire to continue to be active and sometimes even to live.

The approach to technical vision aids is admittedly neither simple nor immediate. Some visually impaired people are reticent about adopting vision aids - which nevertheless meet their needs and have proven effective – simply because it requires effort and a certain adaptation period in order to learn to use them. Support then consists of a professional approach by specialists who have learnt to work as a team with the various parties involved in treatment, of course, but who are also aware of the psychological stages gone through by a visually impaired person. They understand the difficulties experienced with the announcement of the condition and the associated impairment, know how to identify the different stages of its development, to respect them and accept the normal reactions inherent in being told this painful news.

Their professionalism consists of listening, explaining, patiently making suggestions and empathising, without ever falling into the trap of being over-protective or claiming "good intentions". They know how to tactfully suggest to their clients and patients, the aids that will allow them to find a new taste for life and again carry out their favourite activities, even if it is otherwise.

Working as a team allows the same notions to be repeated, using different words in different contexts and so helping the person to integrate all these ideas that are so new and so worrying.
Time allows the visually impaired person to understand their impairment but also their capabilities and their limits, and to learn to use their vision aid, understand all the services that it can provide for them, to travel the winding road through their deficiency and become familiar with this new tool which is so different from the simple pair of spectacles that they were hoping for.
Careful assessment allows the practitioner to understand their client's visual condition and help them understand their actual needs.

Also, we should emphasise the fact that rehabilitation has a preventive role in the risk of depression and the risk of falls. It allows the patient to maintain their independence and, for some, to remain at home.

We should also remember that, whatever the visual difficulties experienced by the patient, however slight they may be, early rehabilitation of the visual disability is always preferable. It often allows a simple adjustment and, in the event of aggravation of the condition, offers the person who has already acquired a new vision process, to quickly find new adaptation mechanisms.

Finally, let us not forget that **the best vision aid is, above all, the one that gives the visually impaired person back the pleasure of doing things**. It is only under this condition that it can prove useful, give back a better use of the person's vision and so help them to live a better life.

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Designed and written by:
Geneviève Prévost with contributions from Dominique Martin

Coordination:
Dominique Meslin, Essilor Academy Europe
With contributions from Anne Catherine Scherlen

And contributions from:
Mo Jalie and Geoffroy Meynet
for the English version

Graphic design:
Okom Agency

www.essiloracademy.eu