Vision Rehabilitation in Practice

(For General Ophthalmologists)

2025

Introduction

As general ophthalmologists, we encounter a diverse range of patients whose visual needs are not solely addressed through medical or surgical interventions. The impact of vision loss on daily functioning and quality of life underscores the importance of a multidisciplinary approach to patient care. This text aims to provide ***general ophthalmologists*** with practical strategies and insights into implementing vision rehabilitation techniques that capitalize on neuroplasticity. Neuroplasticity refers to the brain's ability to reorganize and adapt its structure and function in response to changes in visual input. This remarkable capability allows the visual system to compensate for ocular disorders, adapt to new visual experiences, and even improve visual functions through rehabilitation.

Vision rehabilitation of early childhood: The visual system undergoes critical development during the early years of life, and any disruptions whether due to congenital or hereditary eye diseases, postnatal illness or injuries can have lasting effects. Early intervention not only enhances neuroplasticity but also supports the brain's ability to reorganize and adapt to visual challenges. By implementing rehabilitation techniques at an early stage, we can promote the development of essential visual skills, improve functional vision, and facilitate better integration of visual input.

For general ophthalmologists, recognizing the importance of timely and effective rehabilitation strategies can significantly influence the visual outcomes of children and overall quality of life.

Vision rehabilitation for adults

Different techniques that stimulate neuroplasticity can lead to meaningful improvements in patients' ability to perform daily activities, enhancing their independence and overall well-being.

Basically there are two types of rehabilitation:

1- Medical rehabilitation (The Ophthalmologists Role) focuses on enhancing the functional vision of individuals with visual impairments through various interventions. These include:

- Therapeutic Techniques: to start vision therapy exercises designed to improve visual skills and processing.
- Low Vision Aids: to maximize the use of remaining vision.
- Assistive Technology**:** Software and devices that support visual tasks, such as screen readers and braille displays.

2- Social rehabilitation (team work role) aims to improve the overall quality of life for visually impaired individuals by:

- Orientation / Mobility Training as well as Community Integration Programs

By addressing both the medical and social aspects of vision impairment, a comprehensive rehabilitation approach can significantly enhance the independence and well-being of visually impaired individuals.

Dr. Boshra Elbayoumi

Table of Contents

Chapter 1 : Epidemiology of vision impairment **1**
Dr. Asmaa Mohammed Elasmay

Chapter 2: Visual system and developmental milestones. **3**
Vision rehabilitation of infants and preschool age children.
Dr. Boshra Elbayoumi

Chapter 3 : How to examine a low vision patient (comprehensive assessment) **9**
Dr. Asmaa A.M. Attya

Chapter 4: Patient's selection according to the field defects. **13**
Dr. Alaa M. Saleh

Chapter 5: Types of Magnification and how to calculate the required magnification **17**
Dr. Esraa Samy El Ghoubashy

Chapter 6: Types of low vision devices for near **23**
Dr. Esraa Samy El Ghoubashy

Chapter 7: Low vision devices for far. **27**
Types of telescopes (indoor, outdoor telescopes and Field Expansion Aids) advantages and disadvantages.
Dr. Rania Gamal Eldin Zaki

Chapter 8: Low vision aids in school age children **35**
Dr. Rabab M. Elseht (Tanta University)

Chapter 9 : Computer Assisted, smart phones, low vision applications for visually impaired **41**
Dr. Shahenda Ahmed El-gharbawy

Chapter 10 : Non-optical Aids **45**
Dr. Nada Ismail Saad

Chapter 11: Environmental Modification in Vision Rehabilitation: Enhancing Independence and Safety **51**
Dr. Asmaa Mohaammed Elasmay

Chapter 12: Low vision in common eye diseases **53**
Dr. Ameera Hamdy Mohammed

List of Tables

Table 1 Signs of normal and impaired visual development according to age 4
Table 2 Objective VA for near distance vision 20
Table 3 Objective VA for far distance vision...21
Table 4 Magnification factor between successive lines of Log MAR acuity............................29
Table 5 Visual acuity charts in school age 36

List of Figures

Figure 1 Teller acuity cards...4
Figure 2 Contrast sensitivity testing 5
Figure 3 Vision stimulation 6
Figure 4 Eye hand coordination 7
Figure 5 Snellen chart...9
Figure 6 Log MAR chart 9
Figure 7 Bailey Lovie reading chart...9
Figure 8 Keeler A series chart 9
Figure 9 MNREAD acuity chart...10
Figure 10 McClure reading test..10
Figure 11 Pelli Robson contrast sensitivity test 10
Figure 12 Lea contrast sensitivity test 10
Figure 13 Trial frame..11
Figure 14 Phoropter...11
Figure 15 Relative size magnification...17
Figure 16 Relative distance magnification 18
Figure 17 Angular magnification 19
Figure 18 Projection magnification...19
Figure 19 Spectacle magnifiers 23
Figure 20 Hand magnifiers...24
Figure 21 Stand magnifiers 25
Figure 22 Dome magnifier 25
Figure 23 Ruler magnifier 25
Figure 24 Gallelian telescope 27
Figure 25 Keplerian telescope 28
Figure 26 Hand held / wrist telescope 30

Figure 27 Hand held / wrist telescopes......30
Figure 28 Spectacle mounted monocular telescopes......31
Figure 29 Binocular telescopes......31
Figure 30 Bioptic telescopes......31
Figure 31 In-the-lens telescope......32
Figure 32 Cardiff acuity test......37
Figure 33 Kay picture test......37
Figure 34 Lea symbols for far & near......37
Figure 35 Pelli Robson contrast sensitivity chart......37
Figure 36 Dome shaped magnifier used by child......39
Figure 37 Galelian telescope for distant vision......39
Figure 38 Closed circuit TV......40
Figure 39 Accessibility options......41
Figure 40 Talking calculator......42
Figure 41 Youtube voice command features......43
Figure 42 Large printed book and large button telephone......45
Figure 43 Large printed games......46
Figure 44 Typoscope......47
Figure 45 Tints ion different forms (clips & glasses)......47
Figure 46 A yellow acetate sheet......47
Figure 47 Task lighting......48
Figure 48 High contrast tap......48
Figure 49 Increased contrast helps patients maximize visual recognition......48
Figure 50 Eccentric "E" used to retrain fixation away from a central scotoma......49
Figure 51 Liquid indicator and talking tins......50
Figure 52 Tactile reading by Braille......50
Figure 53 Macular degeneration......53
Figure 54 Retinitis pigmentosa......54
Figure 55 Glaucoma......55

Chapter 1: Epidemiology of Vision Impairment

A Global Perspective

Introduction:

Vision impairment is a significant public health concern, affecting millions worldwide. Understanding its epidemiology, including prevalence, causes, and risk factors, is crucial for developing effective prevention and treatment strategies.

Statistical facts:

- **Global Prevalence:**
  - At least 2.2 billion people have a near or distance vision impairment, according to the World Health Organization (WHO).
  - Nearly half of these cases (1 billion) are preventable or unaddressed, emphasizing the need for accessible eye care services.
  - Among working-age adults (15-64 years), over 437 million individuals live with vision impairment, representing a 91% increase since 1990. **(Resnikoff et al., 2020)**
- **Leading Causes:**
  - **Cataract:** 94 million cases of distance vision impairment or blindness globally. (WHO, 2023)
  - **Refractive errors:** 88.4 million cases, primarily uncorrected presbyopia and myopia. (WHO, 2023)
  - **Age-related macular degeneration (AMD):** 8 million cases, a major cause of blindness in older adults. **(WHO, 2023)**
  - **Glaucoma:** 7.7 million cases, leading to progressive optic nerve damage and vision loss. (WHO, 2023)
  - **Diabetic retinopathy:** 3.9 million cases, a complication of diabetes that can damage blood vessels in the retina. **(WHO, 2023)**
- **Regional Differences:**
  - Low and middle-income countries (LMICs) have a disproportionately higher burden of vision impairment compared to high-income countries.
  - The prevalence of distance vision impairment in LMICs is estimated to be four times higher than in high-income regions. **(Resnikoff et al., 2020)**
  - Lack of access to affordable eye care and preventive measures contribute to these disparities.
- **Additional Risk Factors:**
  - **Age:** Vision impairment prevalence increases significantly with age due to age-related eye diseases like AMD.

- **Socioeconomic status:** Lower socioeconomic status is associated with increased risk of vision impairment due to limited access to healthcare and healthy lifestyle choices.
- **Underlying health conditions:** Diabetes, malnutrition, and other chronic diseases can increase the risk of developing eye problems.

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2- World Health Organization (WHO). (2023). Blindness and vision impairment. https://www.who.int/news-room/fact-sheets/detail/blindness-and-visual-impairment

Further Resources:

1- International Agency for the Prevention of Blindness (IAPB): https://www.iapb.org/

2- Vision 2020 Global Initiative: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1706052/

Remember, this is just a brief overview, and the field of vision impairment epidemiology is constantly evolving. For more specific or in-depth information, please consult the provided references or conduct further research.

Chapter 2

Visual system and developmental milestones

Development of the visual system immediately starts after birth via visual stimuli and interactions with the environment, i.e., neuropsychomotor development,visual-motor coordination, cognitive abilities, and behavioral,environmental, and sociocultural adaptation) [1].

After birth, the visual system undergoes a continuous maturation process involving the eyeball and pathways and neural networks of cortical areas and cortical association areas that integrating different parts.

In early life, development of the still immature retinas is accelerated by the fovea and macula, the optical pathways are partially myelinated, and the visual cortex is rudimentary) [2].

Anatomical changes occur in the visual maturation process, such as the increase in central cone density and elongated outer photoreceptor segments, which develop slowly until age 7 years, enabling progressive improvement in functional vision and development.

At 15 days after birth, visual acuity is estimated at 20/400. At this stage, the child shows interest in objects >10 cm in diameter. Considering normal visual development and cognitive development, children up to age 18 months have similar vision to adults, and a fully developed visual system is perceived until the child becomes 10 years old.

The visual system's ability to interpret perceived images is developed following cognitive development together with other skills related to child development, forming and organizing the visual repertory. Stimuli,motivations, and visual experiences are important for maturation of the visual system and its developmental functions [3].

Visual impairement in infants and toddlers

Knowing the key steps in normal visual development for each age group is therefore crucial in detecting early signs of delayed visual development. Decreased sensitivity to bright lights, delayed or absent eye contact, slowed development of an intentional social smile, lack of awareness of an infant's own hands, the absence of goal-directed hand movements, and failure to fixate on familiar objects such as toys and faces may all be warning signs to the parents and/or the pediatrician of low vision**.**

Once children become mobile, signs of low vision may be more obvious due to clumsiness with crawling, difficulty reaching for toys, and holding objects very close to the face. Older children may start to verbalize symptoms of blurry vision, eye strain or headaches. As gross and fine motor skills develop hand-in-hand with visual processing, any delays in motor development should warrant an eye exam to rule out concomitant low vision [4].

Table 1 Signs of normal and impaired visual development according to age

Age	Normal visual development	Signs of possible visual impairment
Birth-4 months	Focusing on and tracking familiar objects	Decreased sensitivity to bright light, absent or delayed blink reflex to threat or light, slowed development of intentional social smile, nystagmus
5-8 months	Depth perception, facial recognition, color vision	Delayed or absent eye contact, failure to fixate on objects or familiar faces, strabismus
9-24 months	Hand-eye coordination, grasping objects, crawling	Lack of awareness of own hands, absence of goal directed hand and/or arm movements
>24 months	Crawling, walking, exploring the environment	Clumsiness with crawling, difficulty reaching toys, holding objects close to the face, problems navigating curbs or steps
School-age	Reading	Difficulty with reading, complaints of headache

Evaluation

1-History

Taking time to obtain a thorough history regarding onset, severity and progression of low vision symptoms is critical. In addition to standard history questions regarding timing of onset, severity, and progression of visual symptoms, the following components should be included in the pediatric low vision history:

1. Family history of visual impairment
2. Degree of impairment the child has in day-to-day activities
3. Impact of visual symptoms on the child's wellbeing and psychosocial functioning
4. Prior use of low vision aids, including spectacles
5. Difficulty with near tasks and mobility.

2-Visual acuity:

* 0-36 months: Teller Acuity Cards (Figure 1) are the gold standard for visual acuity testing in this age group and have been validated for children with low vision. Teller acuity cards rely on the patient's behavior and eye movements in response to being shown a series of cards with different gratings.

* 4-7-year-old: LEA symbols have been validated for pre-literate children. Landolt C or HOTV optotypes can be alternate options for older children who have started to learn letters but may not know the alphabet consistently well enough to perform Snellen testing [5].

Figure 1 Teller acuity cards

3-Visual field assessment:

In young children can be difficult. Nonetheless, results are important for understanding the impact of low vision on a child's mobility and visuo-spatial orientation.

Confrontation visual fields: Testing should be performed by having the child focus on a central object, while moving colorful targets into the peripheral field. How far the peripherally moving objects travel before the child notices them is the border of the visual field.

4-Contrast Sensitivity

Results of contrast sensitivity testing (Figure 2) may provide insight into a discrepancy between a child's formal visual acuity testing and their day-to-day visual functioning, as decreased contrast sensitivity may correlate with poor visual functioning despite relatively intact visual acuity. [6]

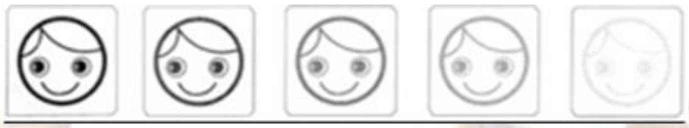

Figure 2 Contrast sensitivity testing

5-Color Vision

Assessing a child's color vision may help explain difficulties with object recognition, as well as anticipate future challenges with schoolwork. Red/green color vision is evaluated using the Ishihara test.– Other validated color vision tests for children with reduced visual acuity include the Farnsworth D-15 test, or the abbreviated Mollon-Reffin minimalist (MRM) test. The Color Vision Testing Made Easy can evaluate for red/green deficits as early as 4 years of age [7].

6-Refractive Workup

Although difficult due to poor visualisation, all such children should be refracted and appropriate spectacle correction should be instituted. Cycloplegic refraction remains the single most important objective test. Children with low vision who complain of photophobia can be prescribed tinted lenses, both for distance and near . Additionally, tinted lenses can provide contrast enhancement of objects. Special absorptive filters and side shields can also be added to glasses [8].

Early intervention

From the beginning of extrauterine development, the child must receive continuous stimuli and visual experiences to develop the optical system in order to present expected visual responses in each age group.

The literature suggests that the crucial role of early intervention as "neuroprotective" strategy, which stimulates brain development, particularly during the window of maximal plasticity to foster the future development and quality of life of the child.

Parent-infant intersubjective interaction is the first natural environment in which the early intervention can take place, so family has a fundamental role being an active participant and its satisfaction and perceptions are important indicators of the quality of care of the early intervention received [9].

1-First 3 months(fixation stimulation activities):

a)Vision stimulation: Various activities may be taught to parents to initiate vision stimulation at home. To improve the fixation behaviour of the child, a variety of large toys,especially self-illuminated toys, may be used to capture attention (Figure 3). A variety should be kept as boredom may set in with the same object kept for too long. The caregiver should be instructed to hold the infant close to their face while talking to the child; they may also wear bright colours and ornaments to attract the child's attention.

Initially, these fixation stimulation activities should be carried out in a dark room with lighted toys and torch light with colourful filters. As the fixation of the child starts to improve, high-contrast images such as black on white or blue on yellow etc. may be used in daily dealings, such as clothes, bedsheets, and wall paints, to attract the toddlers' visual attention [10].

Figure 3 Vision stimulation

b) Tracking :

Once the fixation starts to develop, an effort should be made towards the development of localisation and tracking of objects. Tracking of objects initially begins horizontally, and then eventually vertical tracking of objects develops. This can be initiated by rolling a ball across the room, blowing out soap bubbles, or hanging a central disco ball on the ceiling, so that the child can follow the visual stimuli. Once a good fixation and eye-tracking develop, the toddler should be encouraged to maintain eye contact with the caregiver [11].

c) Eye-hand coordination :This enhances social interaction and hence aids in the holistic development of the child. It is initially initiated by activities such as building block towers, putting marbles into a container, and unscrewing bottles .

Figure 4 Eye hand coordination

2-Older children :Few authors advocate the use of computer-based visual stimulation programs that use passive high-contrast checkerboard stimulation, oddball stimulus design along with auditory feedback. However, these are suitable for slightly older children between 2 and 5 years of age [12].

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Chapter 3
Low Vision Assessment

Consulting room equipment:

Low vision consulting room is somehow different from the usual ophthalmology consulting room.

Distant vision charts:

For examining distant vision, the Snellen's acuity chart (fig.5) is of limited value in examining low vision individuals, but the Log MAR acuity charts (fig.6) have advantages over it. In summary, line and letter spacing is equal throughout the chart with consistent size ratio and there is an equal number of letters in each line. This gives the low vision patient the choice to read from five letters which is encouraging, and the chart is easily converted for use at different distances.

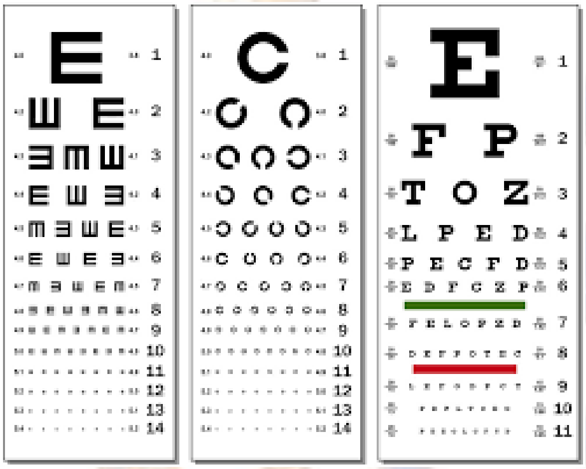

Figure 5 Snellen chart

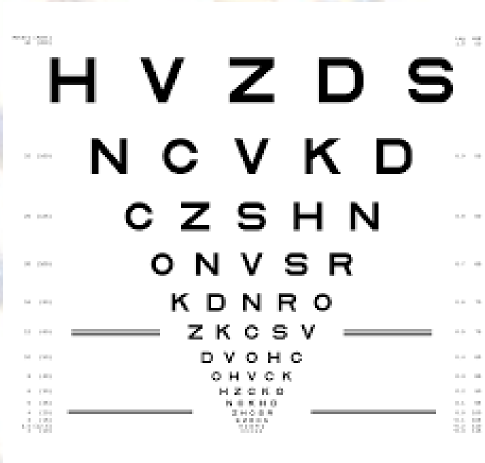

Figure 6 Log MAR chart

Near vision charts:

There are various types of near vision and reading charts like the faculty of ophthalmologists times new roman chart, Bailey Lovie word reading chart (fig.7), keeler A series chart (fig.8), MNREAD acuity chart (fig.9), McClure reading test (fig.10).

It is important to notice the patient's reading performance and speed not only the ability to read.

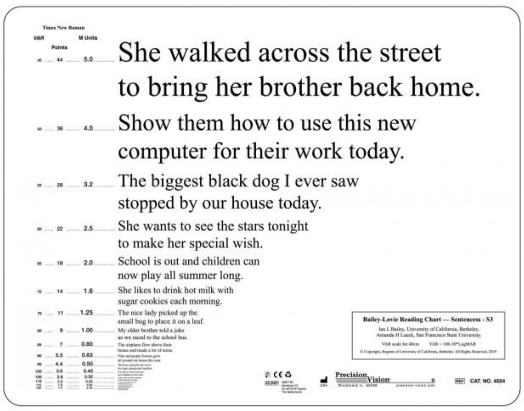

Figure 7 Bailey Lovie reading chart

Figure 8 Keeler A series chart

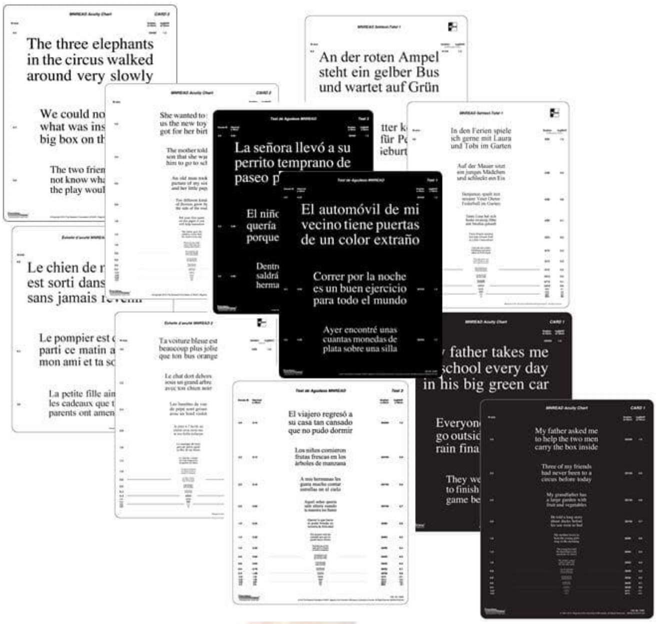

Figure 9 MNREAD acuity chart

Figure 10 McClure reading test

Contrast sensitivity testing charts:

Many Bailey-Lovie charts have a reduced contrast version on their back side. Electronic charts, such as City 2000, allows the contrast to be changed and acuity may be taken at different acuity levels. Pelli Ropson contrast sensitivity test (fig.11) and Lea contrast sensitivity charts (fig.12) are also useful.

Figure 11 Pelli Robson contrast sensitivity test

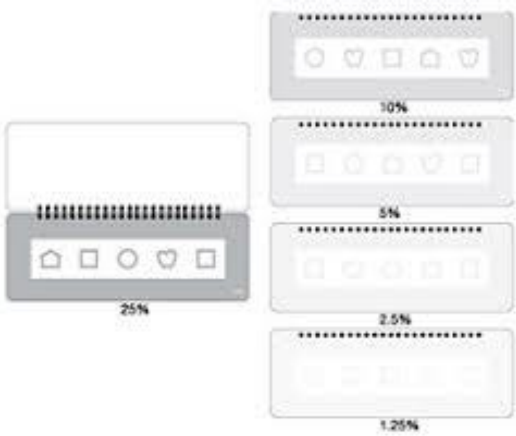

Figure 12 Lea contrast sensitivity test

Refraction equipments:

Trial frame (fig.13) is better than the phoropter (fig.14) as the later obstruct patients who adopt an abnormal head posture, decrease illumination and hide the patient’s facial expression.

Figure 13 Trial frame

Figure 14 Phoropter

Low vision aids and devices should be available at the consulting room to give the chance for the low vision person to try them on real land and decide which device will be suitable for his needs.

First visit:

Before the assessment an initial questionnaire is useful in helping patient to focus on their individual problems prior to consultation.

The aim is not to prescribe a thing that fits but to take the first step in a number of consultations, a low vision aid is not the end of the road. Thorough discussion to clear explanation is as important as prescribing a magnifier.

History and symptoms:

It is helpful for the consultant to initiate the discussion by introducing himself and explain his role, this relaxes the patient and limit unrealistic expectations.

Guided by history the counselor determines the effect of the patient’s vision situation on his lifestyle, daily vision requirements and special hobbies e.g. problems with mobility, face recognition, light sources or glare

A detailed task analysis to determine the need for near device, distant device or mobility training as well as the need for spot checking or fluent reading.

The patient’s general health help in determining the suitable aid for the patient e.g. hand magnifiers are unsuitable for Persons with arthritis or tremors. Also, the low vision condition can affect the proper medication intake.

Discuss with patient about current spectacles and low vision aids he used before (usefulness and limitations of current low vision aids as well as any problems faced with previous aids.

Assessment of visual functions:

Recording distant visual acuity; better to use Log MAR chart than Snellen chart

Useful role of thumb to add 0.3 to the measured VA for every time the distance of chart is halved. The distance from chart must be noted to ensure acuity between successive measures.

If the patient uses eccentric viewing this also should be noted as these patients may benefit from using eccentric viewing strategies

The difference in acuity between both eyes should be noted as well as binocular visual acuity, some cases of nystagmus show improvement of binocular acuity more than monocular like albinism. It is also important to know which eye is preferred to be used by the patient most likely, it is not always the one with better acuity e.g. the previously amblyopic or squinting eye that now retain the better vision will not be the preferred eye.

Near visual acuities are not restricted to recording N-point notation but also reading speed when using different magnifiers should be taken into consideration.

A useful tip is to use the distant acuity as a base for prediction of near visual ability. This also useful for expecting the level of magnification required for a task.

For example near LorMAR scores for 25 cm will reflect the same scores for the 4 meter distant chart. Although this may be useful it is very approximate .Moreover there are some conditions which affect distant and near acuities differently eg. macular degeneration or posterior subcapsular cataract affect near vision more than distant but Nystagmus do the reverse.

Contrast sensitivity measurement detected by a reduced Pelli-Robson score or noticeable difference in acuity at different contrast levels should immediately highlight the need for incorporation of a specific advice about light in management plan or need for reversed magnification

Adaptation to low vision examination:

For distant refraction you may use large steps as patient with low vision eg.2/60 may not appreciate the difference of +/- 0.25 so the practitioner may prefer to use larger steps appropriate for the level of VA. Correction of significant refractive errors or large cylindrical correction is still important although there is no improvement of subjective improvement in central VA. this is because persons with central scotoma prefer to wear the full correction to improve quality of peripheral image as well as if a near device will be prescribed the magnification of a poor quality image will be worse if a cylindrical error not corrected.

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Chapter 4

Low vision rehabilitation of visual field defects

Types of visual field defects:

1. Central visual field loss (central scotomas).
2. Peripheral restrictions (tunnel vision).
3. Other visual field defects (cortical causes of visual field defect for example: quadrantanopia and hemianopia) [1].

Central visual field loss

Characteristics:

People who lost the use of the central area of the retina (macula) usually have a visual acuity below 0.1 (6/60 or 20/200).

Their central scotoma interferes with their ability to see details and discriminate colors, which results in problem when:

- Reading.
- Recognizing people.
- Looking at signs and landmarks in unfamiliar places.
- Inspecting untidy clothes or the home's need for cleaning,
- Orientation, cycling and driving

Causes:

- Macular degeneration.
- Strokes.
- Tumors.
- Scars from eye injuries, traumatic brain injury.

In order to read well, it is essential to have a clear and large enough image in the central part of the retina (macular). It is possible to read outside the macula, but here the sensitivity is far lower, and this makes it necessary to magnify the letters to compensate for the decreased sensitivity [2].

If there is a central scotoma, the patient can be trained to use areas outside the macula to view objects. This is called eccentric viewing. This method is dependent on the ability to find other areas with more sensitivity that damaged macula and make the patient aware of them. These areas are called the Preferred Retinal Locus, (PRL) or the Best Retinal Area, (BRA).

There are four basic steps to train eccentric viewing

1- Identify the Best Retinal Area
2- Chose a fixation area that allows the text to fall on the BRA.
3- Compensate for the lower resolution of the retina in the BRA by using magnification, (spectacle magnification or a closed-circuit TV (CCTV) is ideal for this).

4- Hold the eye steady and move the text when reading – try not to move the eyes – this is the steady eye technique.

Eccentric viewing works best when patients are trained to hold and sustain the use of the fixation angle to keep the words in the BRA. This means training the eyes to have optimal fixation stability, which takes time and effort. We need to train patients to hold their eyes still and sliding the text in from the side when they read. This training will reduce the tendency to saccade and allow the patients to hold the fixation in the BRA for longer time allowing better reading speed.

Research shows that the crucial point for success is the fixation stability rather than the exact use of the BRA.

Each patient might have more than one useful area in the retina they can use for different daily activities.

If the PVI has a BRA in the lower part of the retina, he needs to LOOK UP in order to be able to detect objects in front of him! For example, he may need to look over people's heads to better recognize them [3].

Peripheral restrictions

Characteristics

– People with tunnel vision or peripheral restrictions may still have central vision that is quite good.
– The visual acuity recorded on a test chart could be relatively normal.
– However, because they cannot see to the sides, they do not have an overview of spaces around them. This can make it very difficult to orientate themselves in unfamiliar places, cope with an object that is moving, or even walk without bumping into obstacles.
– Since the peripheral retina controls vision in low light, the functioning of patients with tunnel vision is totally dependent on the level of light. When the light is good, they can read or look at things with their central vision. However, when the light is very low or at night, they may be functionally blind (night blindness).

We could say that PVIs with normal central vision and restricted peripheral vision are partially sighted during the day, but functionally blind when the light is low [4].

Patients may need training with both optical and compensatory devices to help with their visual disability.

Compensatory devices such as white canes, guide dogs or a friend to guide them in unfamiliar environments can be of significant help.

Reading can also be a problem for people with restricted visual fields: if they use normal saccade, they will lose large sections of the text (the fixation field is too small). They might fail to get an overview of the printed page, and struggle to change lines accurately as they may not see the beginning of the next line when they reach the end of the previous line of text.

Diseases commonly associated with peripheral restrictions:

- Retinitis Pigmentosa (RP)
- Laser treated diabetics
- Glaucoma

Training needs

1. **Magnification**. If magnifiers are needed to compensate for lower visual acuity, the patient should use the lowest possible magnification to allow the best retention of usable visual field. If the magnification is exaggerated the already poor central visual field will be even more restricted. If he has good central vision the field expanders may play a rule that cause minification of the image and expanding the restricted field.
2. **Contrast**. In some cases where the central acuity is preserved, the contrast sensitivity may still be poor. In these cases, it is vital to ensure contrast is maintained by using good quality print or electronic screens.
3. **Scanning**. To compensate for the missing field of view, they should look in a systematic way (left to right or top to bottom). When reading, they should first scan the page to get an overview of width, layout, texts and pictures.
4. **Reading technique**. If the remaining central vision is greater than 7 degrees, normal reading saccadic techniques can still be used.
   With smaller areas of residual central vision, the patients must use shorter fixation movements (saccades) than used in normal reading behavior. This will reduce the reading speed but can allow the patients to navigate the page more reliably.
5. **Tracing.** A PVI with restricted periphery cannot easily find the beginning of the next line and may skip lines. To help, a thumb can be used to mark the beginning of the line being read, or a piece of contrasting card laid on the page can be used to highlight the current line [5].

Other visual field defects due to neurological causes

Characteristics

Damage to the visual cortex or the optic nerve cause people in this group to have a variety of visual field defects. The defects in this group are more or less complete restrictions in both eyes located to the left- or right-hand side of the visual field (homonymous). In many cases, the patients have good visual acuity but have lost half of their side vision (hemianopia) or a segment of the visual field on both sides (quadrantanopia) [6].

Management:

1. Orientation and mobility. Train the patients to move the eyes and the head into the blind area. By repeating this movement, the person will be better aware of objects outside of their static visual field. It is important to train to move the eyes and the head frequently to the blind side to avoid bumping into chairs, bikes or other obstacles.
2. Explorative Saccadic Training can be done by making the patient look at objects in the lost visual field by moving the eyes only, not the head. This can be done by standing behind the PVI and pointing at words or objects on the wall or a computer screen

3. Reading. In cases of hemianopia, the patient can turn the text 90° and use vertical reading (top to bottom). A text that scrolls on a computer screen can also be helpful.
4. Fresnel prisms that are used for homonymous hemianopia
5. Microstimulation of visual cortex to restore vision [6].

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Chapter 5

Types of Magnification

Magnification:

Definition of magnification:

It is equal to the number of times that one object is greater than another. It forces setting a close work distance. In Europe, this reference distance is of 25 cm.

- Formula: M (magnification) = F (power in dioptres)/4
- For 25 cm: every 4D is one magnification.

Types of magnification:

There are several types of object magnification:

- Relative-size magnification
- Approach magnification
- Angular magnification
- Projection magnification

1. Relative-size Magnification

This is achieved by increasing the real size of the object. If we increase the size of the object, the retinal image will also increase at the same rate.

This is the magnification achieved when using large print size ; textbooks with large characters that allow patients with low vision to read at a more comfortable distance. It is also the magnification achieved when using markers instead of pens, which increases the contrast and the relative size.

For example, if the text is increased by double, the retinal image also increases by double (Fig 15).

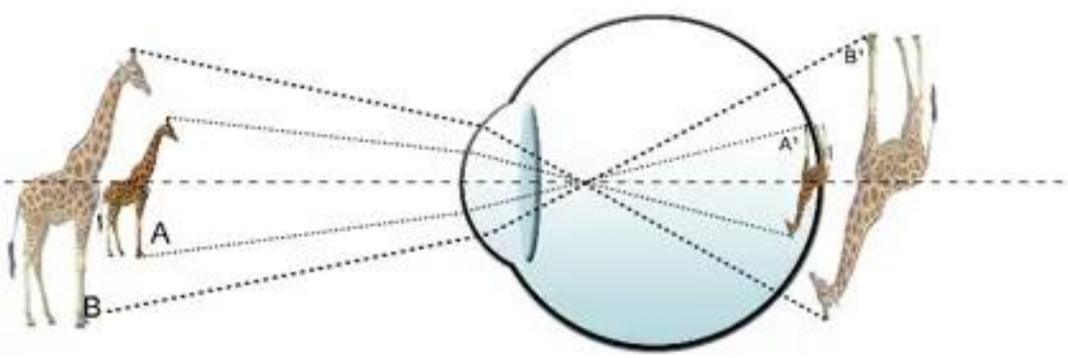

Figure 15 Relative size magnification

In this case: magnification = Object Size B / Object Size A

Advantage:

- Close work distance is not modified

Disadvantages:

- Cost and weight increase with object size
- It is uncomfortable

Example: bigger deck of cards, using marker instead of pen, TV of a bigger size, etc.

2. Relative Distance Magnification (microscopes)

It is the magnification that results from reducing the distance between the object and the eye (Fig. 16).

Whenever an object approaches the eye, the retinal image increases its size in such a way that when the object is at half the distance, the retinal image doubles; if we reduce the distance to a fourth, the retinal image increases four times, and so on. By bringing an object to the eye, the light rays coming from it are increasingly divergent and need compensation so that the eye can see them clearly.

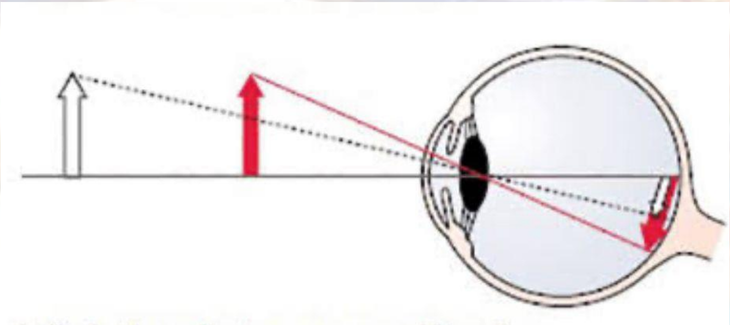

Figure 16 Relative distance magnification

The diopters necessary for seeing an object clearly represent D = 100/d where D is the required diopter and d the distance in cm

Advantages: ability to approach objects with little difficulty

Disadvantages: we lose visual field; a compensation is needed to see objects clearly

3. Angular Magnification (telescopes)

Effect of looking through a telescope. The angular magnification is the ratio between the angle formed by the optical axis and the beam coming out from the telescope divided by the angle that forms the optical axis and the beam that affects the telescope (Fig 17). Telescopic lenses deflect the beams in such a way that, when they leave the telescope, they seem to come from an object that is closer to the eye and therefore they give the impression that the object is much larger.

It results from modifying the angle that subtends the object through an optical instrument when we are not able to put the object close by nor increase its size.

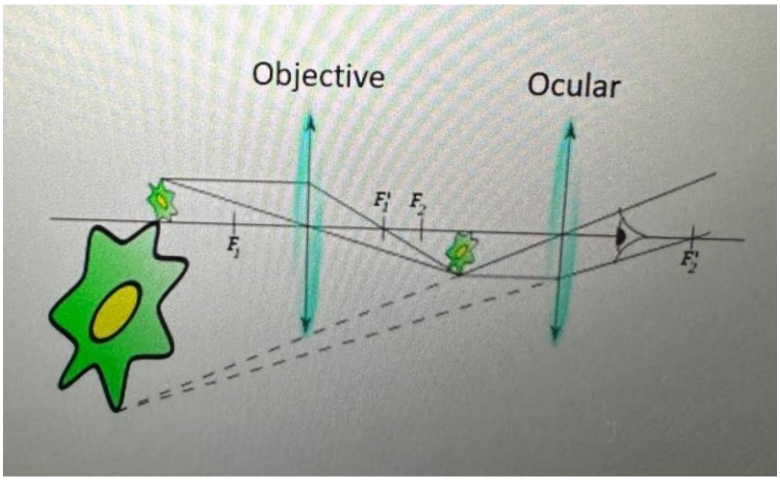

Figure 17 Angular magnification

In this case: magnification = Angle 2/Angle 1.

<u>Advantages:</u>

- Unnecessary to zoom or enlarge objects.

<u>Disadvantages:</u>

- They limit the VF
- They change the spatial perception of the object (it seems to be closer to where it really is)
- There is parallax movement

1. Projection Magnification

This can be achieved with screen projection, as it occurs with slides, CCTV or computer magnification programmes (Figure 18). It has the advantage of using a greater close work distance with greater field without aberrations. However, it is difficult to transport and expensive. When multiple magnification systems are used, the total magnification is the multiplication of each individual magnification. This results with enlarging the image of an object on a screen.

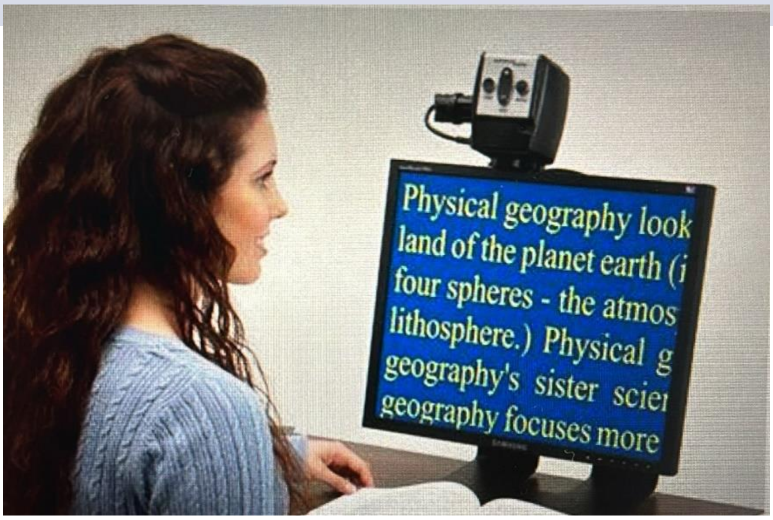

Figure 18 Projection magnification

In this case: magnification = true image size/true object size

Advantages:

- Close work distance
- Wide VF

Disadvantages:

- Price
- Not easy to transport

Total magnification, summary:

- It is possible to obtain it with one of the previous methods and the result will be the multiplication of both.
- For example, using:
    - A magnification of text 3 times greater (3X).
    - We approach that text of 40 cm to 20 cm (2X).
    - The total magnification will be: 3x2 = 6X
    - The retinal image will be 6 times greater and we hope that the VA of the patient will be 6 times greater.

Magnification that someone needs to resolve an object

So far, we have seen the definition of magnification and the different ways to magnify an object but, if someone can't accomplish a task due to their limited VA (i.e., reading), which magnifications would be necessary to fulfil this task?

To find it out, we have the following data:

- Refraction of the patient.
- Available VA (traces of useful vision).
- Necessary VA for the task that wants to be performed (Objective VA).

There are some tables with the necessary VA for the different objectives that the patient can claim, both for distant and close tasks.

Table 2 Objective VA for near distance vision

Necessary VA at near distance	For……
0.5M (0.8)	Package leaflet, bible font size
0.8M (0.5)	Telephone book
1M (0.4)	Newspaper, magazines, primary school books, etc.
2-3M (0.2)	Subtitles, newspaper, sewing, etc.
5M	Newspaper titles

Therefore, considering the VA of the patient, the objective VA can be calculated from the magnification: *Steps:*

1. VA of the patient, for example: 4M (remember that is calculated at 25 cm with ADD + 4.00).

2. VA that we want to obtain, for example 1M (newspaper font size).

3. Magnification calculation: we need to quadruple the VA of the patient, then:

M = VA at a close distance/objective VA → M = 4/1 = 4X; 4X = 16D.

Table 3 Objective VA for far distance vision

Decimal Objectives	For……..
0.6	Streets names, shop windows, etc.
0.5	TV
0.3	Recognising people's faces.
0.1	Locating and manipulating tools.

Then, having the VA at far distance and the objective VA: Steps:

1. VA of the patient, for example 0.1 (remember that is normally taken at 3 m and with the ETDRS).
2. VA that we want to obtain, for example: 0.6 (street names).
3. Let us calculate M: M = VA at far distance objective decimal/decimal VA of the patient → M = 0.6/0.1 = 6 X. TS 6X

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Chapter 6

Magnifiers for Near

Spectacles, stand magnifiers, and hand magnifiers are available in a range of different powers to suit different tasks and different people. Optical magnifiers for near tasks are made of plus (+) lenses and the higher the power, the higher the magnification. As a consequence, high power magnifiers, compared to low power magnifiers have:

- Thicker lenses with smaller diameter.
- More aberrations at the periphery.
- Smaller field of view.
- Shorter focal length.

Spectacle Magnifiers (Fig19):

Spectacle magnifiers can be divided into 3 groups based on the power of the lens:

- Low power (below +8D)
- High power (+8 to +16D)
- Highest power (+18 to+48D).

Spectacles can be used binocularly up to approximately 3x magnification (+12D). If the power needed is less than 16D and the person has a refractive error, he or she can use bifocals. Although it is more convenient to have bifocal glasses, some people have difficulties adjusting to them especially when moving. In this case, it is better to have two pairs of glasses, one for distance and one for near.

Advantages:

1. Wide range of magnification (1x to 12x)
2. Good field of view
3. Both hands free
4. Can be used for long periods
5. Socially acceptable
6. Exact reading distance

Disadvantages:

- High power need short distance and good lighting
- Binocularity hard
- High power is expensive

Figure 19 Spectacle magnifiers

Hand magnifiers (Fig 20)

Hand magnifiers are magnifying lenses mounted with a handle. They are very common and convenient to use.

The viewer controls:

1. the distance between the lens and the object.
2. the distance between the lens and the eyes.

Ideally, the lens is held at approximately the focal length of the lens from the object (Focal length (cm) = 100 / Power). As long as the magnifier is held at the same distance from the object, the optical magnification remains the same even with different eye-to-lens distances, but as the distance from the magnifier to the eye increases, the field of view rapidly gets smaller

Advantages :

- Eye to target distance can vary.
- Can be used binocularly.
- Portable.
- Socially acceptable.
- Easily available.
- Excellent for spot viewing.
- Are available with or without illumination.
- For patients with central scotoma it provides eccentric vision.

Disadvantages:

- Need one stable hand.
- One hand is busy during using.

Figure 20 Hand magnifiers

Stand magnifiers (Fig 21):

Stand magnifiers are useful when magnification is needed for sustained tasks, or if the hands cannot adequately hold the device. These magnifiers have a support to ensure the distance between the object and the lens (focal length) is correct as it is fixed. Because of the support, they often need additional lighting.

Advantages:

- Fixed working distance
- Holds the lens at correct angle to text
- Possibility of binocular use.

- Writing under it possible.
- Can be used with hand tremors.
- Are available with or without self-illumination.
- Can be used easily in children.
- There are aberrations if the patient looks vertically by the center.

Figure 21 Stand magnifiers

Disadvantages:

- Bulky
- Needs flat surface
- Needs accommodation or reading glasses

Bright field magnifiers :

Also called visolett, dome or flat field magnifiers, they produce between 1.5x and 2.2x magnification.

They are clear balls (plastic or glass) (Fig 22): the larger the proportion of sphere used the higher magnification but the lower the field of view.

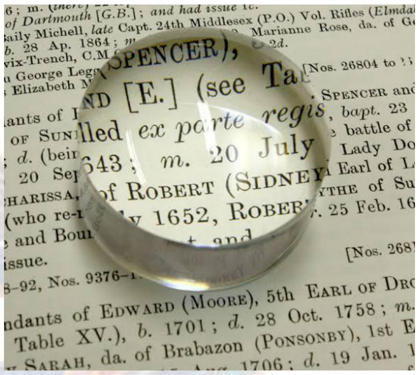

Figure 22 Dome magnifier

The diameter of the dome determines the field of view but also the weight of magnifier. If the user can accommodate (child), these devices can be combined with relative distance magnification (move closer) to supply greater magnification effect. For example, the 2x magnification produced by the dome magnifier can be increased by 2.5x as the child has moved from 25 cm to 10 cm and the total magnification reached is 2 x 2.5 = 5x.

Figure 23 Ruler magnifier

Advantages:

- Simple to use
- Brightens objects
- Combines well with accommodation
- Possibility of binocular use

Disadvantages:

- Needs flat surface
- Low magnification power

Telescopes:

Telescopes can be helpful to most persons with a visual impairment. They are magnifiers composed of at least two lenses mounted in a tube. There are two types: Galilean and Keplerian. As with the other magnifiers, stronger telescopes have a higher magnification but a smaller field of view than weaker ones. Compared to monocular telescopes, binoculars are simpler to use, easier to hold steady, offer a larger field of view and are cheaper. However, binoculars are bulkier and will not focus as close as monocular telescopes.

Mounted telescopes (monocular or binocular) are useful for sustained tasks. In certain parts of the world, bioptic telescopes are used by persons with VA as low as 0.2 for driving cars.

Advantages:

- See objects at intermediate (computer) and far distances.
- Portable.

Disadvantages:

- Need training.
- Small field of view.
- Low social acceptability.

Tele microscopes:

These are telescopes focused on short distances, that is, they carry an added approximation lens or microscope. Usually, they are mounted on glasses in lower positions.

The tele microscope provides a greater working distance than the microscope, but a less effective visual field, so they are only used for a given distance, the depth of focus being more critical than microscopes. Focusable tele microscopes for reading and distance vision from 2.75x to 8x.

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Chapter 7
Low Vision Aids
Optical Devices - Distance Tasks

Objectives: These notes aims to provide the learner with:

- Knowledge of optical devices for distance tasks including magnification specification, advantages and limitations, appropriate visual skills, and care and maintenance.
- Knowledge of methods and materials for teaching visual skills including localizing, focusing, fixation, tracing, scanning, tracking, and distance and depth judgment.
- Knowledge of optical devices used for intermediate tasks, magnification specifications, including advantages and limitations, appropriate visual skills, and care and maintenance

Magnification method of telescopes

Angular magnification: Magnification = angle subtended at eye by telescopic image / angle subtended at the eye by object.

Telescopes

Telescopes: Optical principle

Telescopes are defined as a complex systems, each consist of two lenses separated by a short distance in a metal tube and is described as an afocal system.

When parallel rays enter afocal system, the emerging light also is parallel.

There are two basic types:

- Galilean telescopes (Fig 24)
- Keplerian telescopes (Fig 25)

Optics of Galilean telescopes

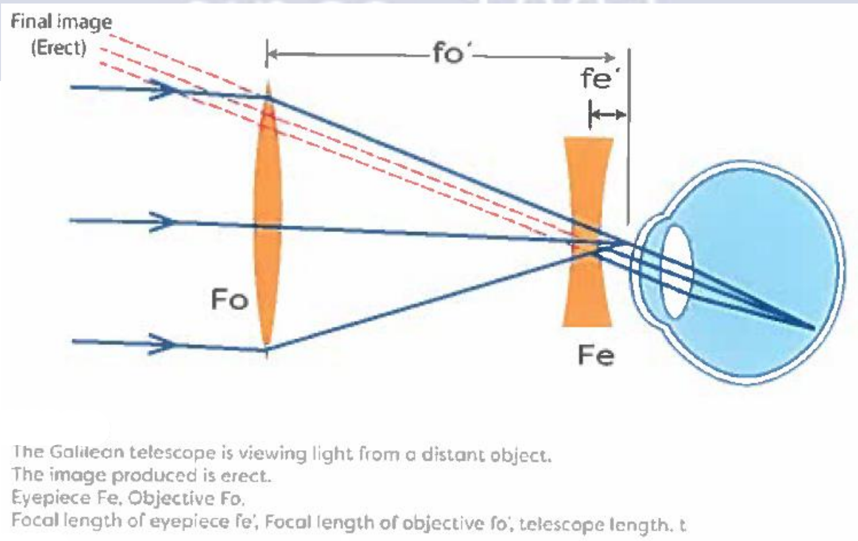

Figure 24 Gallelian telescope

Optics of Keplerian telescopes

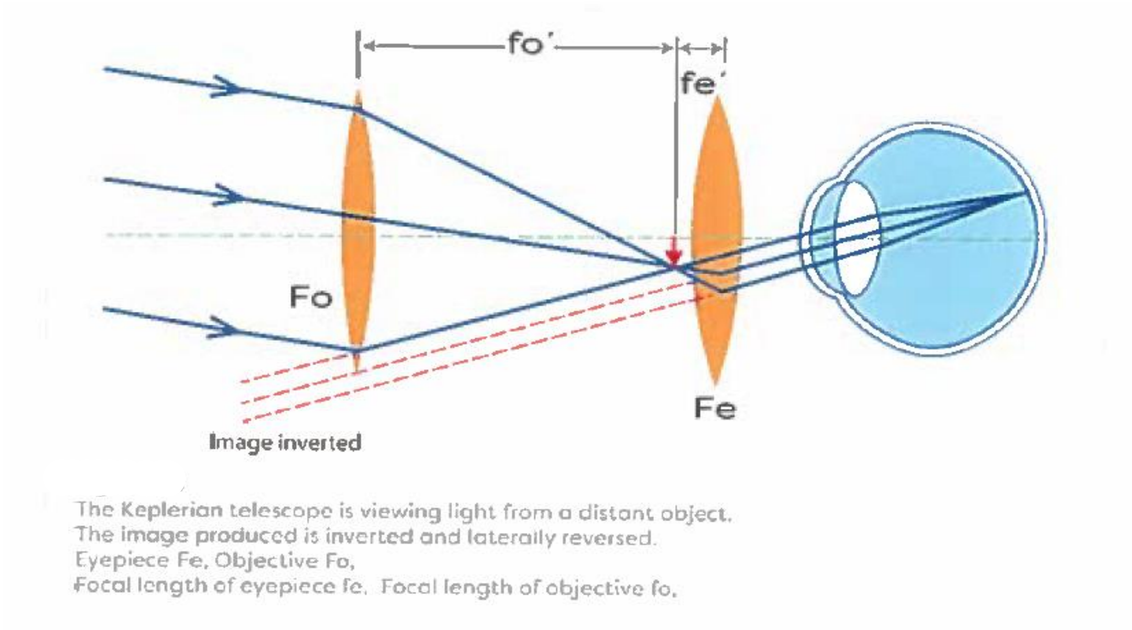

Figure 25 Keplerian telescope

Prescription of visual aids for distance:

- The most commonly used method described by Dickenson, 1998:
- The required magnification (M) = desired visual acuity / actual visual acuity.
- Angular magnification = angle subtended at eye by image/angle subtended at eye by object
- Magnification of telescope = dioptric power of eyepiece / dioptric power of objective
- The inverting prism in the Keplerian telescope increases the weight of the telescope compared to its Galilean counterpart The optical quality of the Keplerian telescope is far superior to that of the Galilean telescope…therefore in clinical practice we use Keplerian telescopes if the magnification needed is 4x or greater

Keplerian telescope worked example:

Magnification (M_{tel})	
Fe	= +40D
Fo	= +20D
M_{tel}	= - 40/20
M_{tel}	= x-2
Telescope length:	
t	= fe' + fo'
t	= (+25) + (+50)
t	= 75mm

Galilean telescope worked example:

Magnification (M_{tel})	
Fe	= -40D
Fo	= +20D
M_{tel}	= - (-40)/20
M_{tel}	= x2
Telescope length (t):	
t	= fe' + fo'
t	= (-25) + (+50)
t	= 25mm

It is well known that the greater magnification the narrower the field of view, thus the least magnification suitable should be prescribed to avoid field restriction

Magnification factor between successive lines of Log MAR acuity (Table 4):

According to number of lines needed to be improved

Table 4 Magnification factor between successive lines of Log MAR acuity

Lines of improvement in logMAR	Magnification required
1	1.26x
2	1.6x
3	2x
4	2.5x
5	3.2x
6	4x
7	5x
8	6.4x
9	8x
10	10x

Prescribing sequence

- Determine best distance correction
- Measure best corrected acuity
- Determine the goal acuity
- Calculate the magnification needed
- Demonstrate the appropriate telescope to the client
- Explain the available options
- Loan a device for home trials
- Design the final prescription

Important notes

- Prescription of low vision aids must be done after complete evaluation of the visual function of the patient.
- Every patient should be dealt with as a unique case
- The age of the patient is an important factor
- Education and social level the design , weight and the price

Correction for ametropia by an afocal telescope

- Spectacle mounted
- Changing the telescope length: the easiest way to compensate for ametropia is to change the length of the tube, for increase or decrease the separation between the eye piece and the objective piece.

Uses of telescopes

TV- reading signs- identify buses- Sports- Board reading

Types of telescopes

Criteria of different telescopes:

Monocular or binocular telescopes

A magnification range from 2.75x to 12x, focusing distance from infinity to 20 cm, can be supplied in different forms as, hand-held , finger ring, neck/wrist cord, clip on/ flip on or fixed spectacle frame mounted (up to 6x), and bioptic designs.

Hand held / wrist cord telescope (Fig 26, 27)

Figure 26 Hand held / wrist telescope

Small handheld telescopes may be easily carried in pocket or purse and brought out as required.

Patients with poor manual dexterity or unsteady hands can find it difficult to hold, align and adjust telescopes, and head born telescopes might be preferable

Figure 27 Hand held / wrist telescopes

Spectacle mounted monocular telescopes (Fig 28)

Figure 28 Spectacle mounted monocular telescopes

Binocular telescopes (Fig 29)

With magnification range 2x to 6x, spectacle mounted

Figure 29 Binocular telescopes

Bioptic telescopes (Fig 30)

Figure 30 Bioptic telescopes

In –the- lens telescope (Fig 31)

Figure 31 In-the-lens telescope

Eagle Eye Telescopic Systems were designed to provide the patient with superior optics in a more cosmetically acceptable instrument. The Telescope is the Designs for Vision Bioptic Model II Telescope mounted in a unique ball socket housing which allows the telescope to be moved by the patient to align the optical axis of the telescope to the visual axis of the patient's eye. This Telescope is very helpful for patients who have eccentric vision in addition to patients who wish to have a more cosmetically acceptable unit than previously available.

<u>**Advantages of telescopes:**</u>

- Distance or near
- Binocular or monocular
- Increased working distance, variable focus
- spectacle mounted: (hands free)- maintain alignment e optical axis- stabilize the device- easier
- Handheld" less expensive- cosmetic more acceptable

<u>**Disadvantages of telescopes:**</u>

- Expensive
- Poor cosmoses
- Heavy
- Require training. Magnification of body movement
- Require good fine motor control
- Poor field of vision
- Spectacle: far from the eye: decrease field

Important notes

The closer the lens – the wider the field

Simple myopia or hypermetropia without astigmatism could be compensated by focusing

People with astigmatism – over glasses or contact lens

People with tremors or arthritis--- spectacle mounted telescopes

Choosing a distance device

- Consider the client's level of motivation
- Consider the size and working distance of primary tasks
- Consider whether the client requires hands free operation (e.g., to hold a book)
- Can the client hold the device steady while using?
- Will the client use the device in public? Does the client like the look of the device?
- Does the aid need to be portable?
- Does the device need its own lighting source?
- What is the cost consideration?
- More magnification means smaller field so magnification should be as small as possible to accomplish the goal

Training guidelines

- Motivation – client understand purpose of the skill, relate skill to goal or target task
- Explanation – how does the device work? What is the proper working distance?
- Demonstration – showing improves doing
- Practice – initial practice should be done under supervision with feedback on performance
- Transfer – training done in the clinic must be transferred to the home or work environment so after the client has used the device for a while, a follow up visit is needed (1-2 weeks, 3 months, 6 months)

The main policy of training for distance vision aids consists of five main items:

1. **Spotting** which means, training the patient to look through the papillary inlet of the telescope.
2. **Focusing**, which means training the patient to change the focus of the telescope according to the distance of the desired task.
3. **Tracing**, which means training the patient to see many adjacent figures or to see an interrupted line.
4. **Tracking**, which means training the patient to follow the contour of continuous line.
5. **Scanning** which means training the patient to scan the whole place searching for a target when he is wearing his visual aid.

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Chapter 8

School age child with low vision

Diagnosis of child visual impairment [1]

<u>History taking using quality of life questionnaire.</u>

1. <u>Reading and near vision</u>
   1. What can the patient read?
   2. What happens when he attempts to read?
   3. Has the patient used a talking book?
   4. Is he an avid reader?
   5. What low vision devices have been tried

2. <u>Activities of daily living:</u>
   1. Can the patient watch television? If so, how close does he sit to watch the television? How large is the television screen? How well does he see the colour on the screen?
   2. Can the patient move independently?
   3. Does the patient use any kind of cane to move?
   4. What are their visual requirements?
   5. Does the patient run into objects or trip on curbs?

3. <u>Light and glare:</u>
   1. How does he function in bright sunlight, indoor lighting and at night?
   2. Whether sunglass is worn? If so, what colour and type?
   3. Does he use hat or visor?
   4. Does the light and glare affect the patient’s mobility?
   5. Does he face difficulty in changing from different light levels?

4. <u>Vocational and educational:</u>
   1. Can he watch the chalkboard?
   2. Is the student attending a blind school or in a mainstream programme?
   3. Does he use large print book?
   4. Are there any computer requirements?
   5. Are there any educational needs?
   6. Is the patient employed or doing any volunteer works
   7. What are visual requirements for their job?

5. <u>Emotional and recreational:</u>
   1. How motivated is the patient?
   2. What support is available to the patient? Does the patient have family or friends to provide support and help?
   3. How is the patient adapting emotionally? Have there been any signs of clinical depression?
   4. What is done for recreation?
   5. Does he have any hobby

Ophthalmogical examination :

- Visual acuity charts (Fig 32-34) : Measurement of distance visual acuity -ability to use all standard paediatric charts. Measurement of near visual acuity – ability to use all standard paediatric charts.
- Contrast sensitivity . (Fig 35)
- Assessment of visual fields – using behavioural methods and formal measures
- Assessment of eye movement – including abnormal movements, pursuit and saccades
- Dilated (cycloplegic) and undilated refraction.
- Ocular and fundus examination.

Visual acuity assessment

Measuring the visual acuity using age-appropriate distance visual acuity tests also the selection of different charts will depend on the mental abilities and development [2,3]

Table 5 Visual acuity charts in school age

Visual acuity test	Test type	Age range
Cardiff acuity test (Fig .32)	Resolution acuity Preferential looking	6m -3 ys
Crowded kay picture test (Fig. 33)	Recognition acuity picture Naming /matching	2-4 ys
Log MAR crowded test (Fig. 34)	Recognition acuity Letter- naming/matching	≥ 4 ys

- Far distance:

  Those with visual acuities of less than 1.0 Log MAR (6/60 Snellen) should be presented with charts at distances of 1–3 metres, whereas those with acuities of between 0.6 and 1.0 Log MAR (6/24 and 6/60 Snellen) should use working distances of 3–4 metres. Six-metre charts should be used only for those whose acuities are better than 0.6 Log MAR (6/24 Snellen).

  Lea symbols for far may be used.

- Near distance :

  Younger patients may understandably choose to utilise accommodation in preference to a near addition, although near acuities should still be recorded at a 25-cm working distance, as well as the patient's accustomed working distance , Lea symbols for near may be used .

Cardiff acuity test (Fig 32):

Figure 32 Cardiff acuity test

Kay Pictures (Fig 33):

Figure 33 Kay picture test

Log MAR of ETDRs charts (Fig 34) :

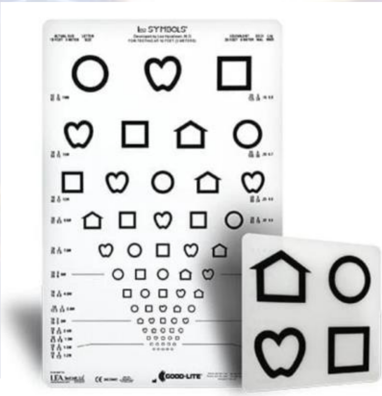

Figure 34 Lea symbols for far & near

Contrast sensitivity test (Fig 35):

Figure 35 Pelli Robson contrast sensitivity chart

Distance Vision Needs And Expectations

Examination of visually impaired child often is the first step in vision rehabilitation, it is designed to accurately measure how one's vision works in the real world - how it functions in day-to-day living.

It's not only about how well you can see an eye chart, but also how well you can see faces, street signs, Television, or blackboard in the school and all the other visual clues that guide them through the day. Perhaps distance vision is the need and an expectation of every patient.

One must understand his possible day to day activities and how distance devices must be advised so that they are utilised.

Near vision requirements patient will have to be asked specific questions about his vision. The purpose is to determine how people can cope with near tasks.

Points to remember when evaluating a child for visual aids:

- Amblyopia can occur in the presence of another visual abnormality and should be treated vigorously. The better the vision, the less magnifying power needed.
- It is acceptable for moderate to high myopes to remove their glasses for near work. (high minus compensate the high plus power, e.g. Patient with -10 D needs +10 for magnification so he can remove the glasses and make the working distance 10 cm)
- The accommodative range will decrease as these children get older, and a change in vision does not necessarily mean a worsening of a previously stable condition.
- Only those visual aids that are needed for the currently performed tasks should be prescribed. For the young child, this will probably mean a stand magnifier for near tasks and a telescope for distance tasks.

The rehabilitation programme

It should also be designed to demonstrate the characteristics of functional vision and to give the individual involved a clear understanding that Low vision aids is a task specific and must explain to the tasks that they should expect to be able to continue to perform.

- The programme must also identify and address the tasks that could be considered uncomfortable, or even dangerous to attempt.
- It should give the visually impaired person the confidence to be able to recognise the visual images upon which they can safely rely and around which they can make good decisions.
- Ideally, it should enable patients to take decisions that affect their lives and to be active, rather than passive, participants in the rehabilitation process.
- Rehabilitation, within the context of this section, considers the needs of people with some residual vision rather than those of people who are totally blind [5].

Factors affecting the prognostic value of vision rehabilitation in children :

- During the examination, the low vision examiner should take a detailed history and ask questions about the individual's functional problems. Also investigate any physical limitations the person may have, which might interfere with the use of certain types of devices.
- Then administer a series of tests to evaluate the patient's visual function, including visual

acuity, visual fields (central and peripheral), contrast sensitivity and colour vision.

- The information obtained from this testing will provide clues about whether devices may be beneficial and, if so, what types of technology to prescribe. The examination for low vision patient is performed by an eye specialist and an optometrist together, where both work on the patient in understanding his pathology and other in assessing his visual needs.
- Assessment of needs of visually disabled patient performing all activities like a normal person may not be possible for low vision patient, however finding the right combination of visual and non-visual devices can enhance the quality of life and give some independence to the patient.

Simple low vision aids suitable for young children:

Optical

- **The phakic school-age child** has an enormous range of accommodation. These children find that reading can be a simple matter of bringing the print close enough to their faces to magnify the image. A fixed-stand low-power magnifier as (dome magnifier) to enhance these images is probably the most useful low-vision aid for these young children. (Fig 36)

  When the magnifier is placed directly on the page, its fixed focus always keeps the print clear and lets the child run the device along the page. Even very young children learn to manipulate these devices, and they have been found more useful than many of the more technically sophisticated and costly aids available today.

Figure 36 Dome shaped magnifier used by child

- **The aphakic child has different needs** However, glasses or contact lenses with reading additions and the same fixed-focus stand magnifiers can be of great help to these children. For far the other aid that is exciting to young children with decreased vision is a monocular telescope (Fig 37), It takes a little longer to master this device, but, once the child learns to use it, it opens a whole new world. The small size of these telescopes makes them highly portable. A child can use this device anywhere and can share it with normally sighted friends, thus erasing the stigma associated with the use of a low-vision aid.

Figure 37 Galelian telescope for distant vision

Non-optical including strategies to advice

The social and academic support (integration)

Success of a child with a visual disability depends largely on the expectations of the family and the understanding of the teachers and the school administrators; the focus should not be on the limitations that the visual disability creates but on the heights that these children can achieve.

- However, staff need to remain aware of the children's special needs and address these needs appropriately. Where these children are seated in the classroom, the distance between them and the blackboard.

- Furnishing the family and the teachers with a detailed report of the size of print that the child can see for both near and distance work is most helpful. When there are problems with contrast on homework assignments (some copies are so poor that enlarging the print makes them impossible to read), a different type of copy for these children is important.
- Students and the Font Size, the magnification of print will depend on the grade or the class in which the student is. It is not necessary to prescribe the near vision print size of M1 level if the child is in nursery class.
- The best is to ask the child to get his school text books so that you can estimate the size of the print child needs to read. Many times, no optical device may be needed at that age. The magnifications may be increased as the child moves to higher classes and the print size goes smaller

- The colour of the chalk used, and the angle of the glare from the windows are all as important as any optical aids.

Non-optical visual aid being used. For some children, a closed-circuit television (Fig 38) however this is expensive but facilitates reading when increased magnification is required, as the magnifying glass of increased power decreases the field of view also the contrast could be changed.

Figure 38 Closed circuit TV

- With increased awareness of and attention to those things that make schoolwork easier to handle, most children will adapt well. However, as the child becomes older and reading demands increase, these more sophisticated instruments will become appropriate and should be added to the armamentarium.

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Chapter 9
Computer Assisted, smart phones, low vision applications for visually impaired

Mobile apps offer a wide range of functionalities and capabilities that can assist individuals with visual impairments in various aspects of their daily lives. By leveraging the capabilities of smartphones, these apps can provide various functionalities that enhance accessibility and independence such as text-to-speech conversion, object recognition, navigation, wayfinding, and accessing information from the internet.

Most **smartphones** have various built-in features and functionalities that can assist visually impaired individuals, but the versatility of mobile apps means that users can find specific apps tailored to their needs and preferences.

1- Built-in tools on Apple and Android devices: such as large font and high contrast.

Apple user:

Voice Over is a screen reader that provides a description of everything happening on screen.

Siri is a voice recognition system that lets patients send messages, place phone calls and more.

Android user:

Talkback: a built-in screen reader

Google Assistant: a "virtual helper" powered by artificial intelligence.

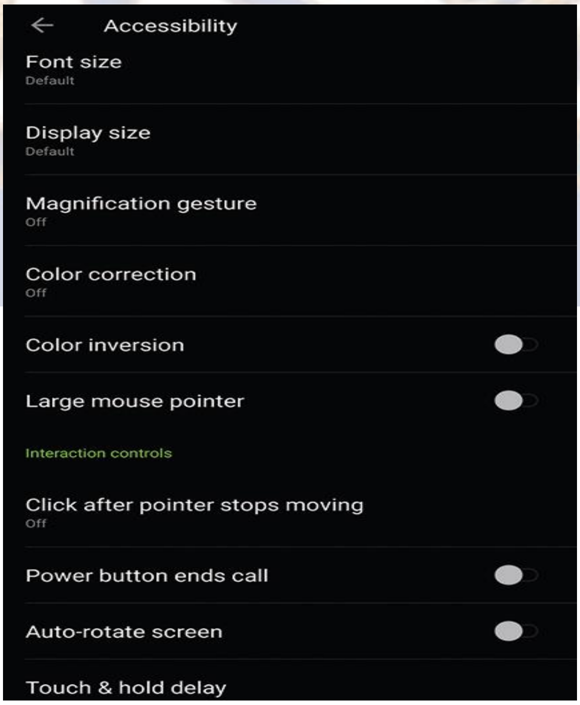

Figure 39 Accessibility options

Accessibility options to improve the text visibility available in all Android smartphones (Fig 39)

2- Daily tasks and object identification

Seeing AI (iOS, free) – This app can narrate the world around patient. Simply point his phone or iPad camera at something, and Seeing AI will tell him what it is, out loud. It can help read currency, name colors and even decipher handwritten cursive.

Lookout (Android, free) – Provides spoken feedback about things around patient by using the camera and sensors to recognize text, people and objects.

Be My Eyes (Android and iOS, free) – This app connects visually-impaired people with sighted volunteers through a live video call. Volunteers “lend their eyes” to help with short, simple tasks such as reading a street sign or troubleshooting technology.

3- Magnification

Brighter and Bigger (Android and iOS, free) – This reading glasses tool uses camera’s light and features adjustable magnification to help people who have trouble reading fine print.

4- Reading

Kindle app (Android, iOS, PC and Mac, free) – An e-reader app that allows to download books. Books can be purchased and directly downloaded from Amazon, or downloaded from library app into the Kindle app. The free Kindle app can be downloaded onto many iOS and Android devices.

5- Navigation and transportation

Soundscape (iOS, free) – Designed for use with stereo headphones, this app provides 3D audio cues about surroundings in real time. It can be used in conjunction with GPS navigation.

Nearby Explorer (Android and iOS, free) – This app combines GPS navigation, turn-by-turn directions in pedestrian and vehicle modes, points of interest, and transit data.

6- Shopping

Blind Bargains (Android and iOS, free) – Lets patients search the web to identify the hottest deals available on talking products, braille printers, accessible gadgets and other products for the visually impaired.

Talking Calculator (iOS, free) and **Voice and Talking Calculator** (Android, free) – Provide a fully voice-operated calculator that reads numbers, formulas and answers aloud (Fig40).

Talking calculator app with high contrast and voice on button presses

Figure 40 Talking calculator

7- Socializing

Facing Emotions (Android, free) – A facial recognition app that uses artificial intelligence (AI) to identify seven different emotions by turning them into sounds that you can hear. The app must be used together with Huawei’s Mate 20 Pro

Instagram (Android and iOS, free) – This popular social media app now includes an alternative text feature that lets users add and hear rich descriptions of photos as they browse. This feature works together with the device's screen reader.

YouTube for Android has expanded its voice command features for video navigation (Fig 41)

Figure 41 Youtube voice command features

Technologies coming soon:

The future of low vision tech is exciting. Tools in development include:

A virtual reality "Canet roller" that aims to help people map out a virtual space by using vibrations and sounds.

An AI-based technology for car windows called "**Feel the View**" will also use vibrations to help "show" what's outside.

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Chapter 10

Non-optical Aids

<u>Non optical methods for visual rehabilitation</u>

There are many others approaches to aid visually impaired patients which may counseled with the patients.

<u>Principles of non-optical aids either:</u>

1. Relative size magnification. (large print).
2. Management of photophobia and glare.
3. Increase light.
4. Eccentric viewing training.
5. Using other sense (tactile and auditory).

1- <u>Relative size magnification:</u>

Relative size magnification:

Retinal image can be increased by increasing the size of the object by the equation M= new object size

Old object size

Most printed material N10 to N12 but large printed books are N18 to N24 which approximately 2 to 2.5 X larger than standard print, increase spacing between the lines and increase contrast all are methods to increase the visual performance.

Relative size magnification includes:

1. Large, printed books and newspaper (Fig 42).
2. Large button telephones (Fig 42).
3. Watches and clocks
4. Games for adult and children (Fig 43).
5. Some household items and kitchen equipment.

Figure 42 Large printed book and large button telephone

Advantages of large, printed books:

1. Cosmetically accepted with normal posture for reading.
2. Binocular viewing of the book.
3. No special training.
4. Increase spacing between lines and increase contrast.

Disadvantages of large-printed books:

1. Costly expensive.
2. Heavy book can be overcome by make the paper lighter but may be transparent and easily damaged.

Figure 43 Large printed games

2- <u>Management of photophobia and glare:</u>

Effect of glare and photosensitivity may significantly decrease in visual acuity some conditions cause severe glare such as corneal pathologies, contact lens problem, follow refractive surgery, uveitis and cataract.

Classification of glare:

1- **Discomfort glare**: large amount of light enters the eye cause discomfort to the patient.

2- **Disability glare:** after cataract surgery scattering of the light cause drop of acuity and impaired patient performance.

3- **Reflecting glare**: as in shinning page or book when it is moved and the angle of incidence of the light not equal the angle of reflection and the print is masked

Management:

1- Treatment of underling cause.
2- Reduction of light.
3- Change in position.
4- Obscuring the light by visor, shield or caps.
5- Multiple pinholes.

1- Resaved contrast print: white writing in black background to decrees the backscattering of light.
2- Typoscope: the same as reversed contrast by black sheet and tracking aid (Fig 44).

Figure 44 Typoscope

1- Tints: sunglasses useful in sunny day and bright light but some degree of tint useful indoor and low illumination, sunglasses useful in decrease unwanted source of light from sides (Fig 45).

Photochromatic glasses often good solution of unwanted effect of discomfort and disabling glare by improving visual performance by absorbing the scattered light and improve retinal image contrast such as patients with stargardt disease and retinitis pigmentosa get benefit from orange and red tint, aniridia and albinism get benefit from tint by reducing the amount of light and may need contact lens with artificial pupil and cone dystrophy patient need dark filter with light transmission factor 2-5%.

Figure 45 Tints ion different forms (clips & glasses)

2- Colored Acetate Sheets (Fig 46):

When placed on the page, a translucent acetate sheet—especially yellow—can enhance the contrast between the print and background, making words and letters appear darker and easier to read (Fig 46).

A yellow acetate sheet can make newsprint easier to read by increasing the contrast and making the print "stand out" from the background.

The yellow acetate sheet fits directly over a letter-sized sheet of paper and can also reduce glare on the reading page.

They are generally inexpensive and are readily available at stationery, office supply, and "big box" stores.

Figure 46 A yellow acetate sheet

3- Lighting:

Good lighting either general lighting or task lighting, general lighting increase by age 60 by 50to 100%, reduce the illumination will result in reduce visual performance for many tasks as decrease acuity, contrast, and color vision.

Task lighting (Fig 47) is important for near task as reading 300 lux need for constant reading and sewing in young people increased to 450 to 600lux in elderly patient and 1000lux in low vision patient, the difference between the task light and background light should not exceed 3:1.

Figure 47 Task lighting

4- Color contrast:

Using of color contrast in home is important for low vision patient for increasing contrast perception such as color masking strips used to demarcate edges as the steps (Fig 48,49).

Figure 48 High contrast tap

Figure 49 Increased contrast helps patients maximize visual recognition

5- Eccentric viewing training.

Patients with macular disease may benefit from learning to view objects with their peripheral vision. Instructions for eccentric viewing training are as follows.

- The boxed "E" is used to determine where the patient needs to look to see the E most clearly. That area is marked on the box with an X. This is the eccentric viewing position (Fig50).

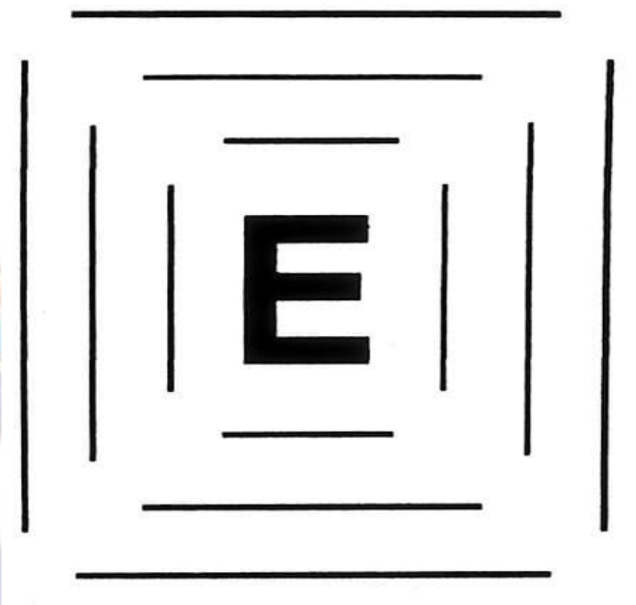

Figure 50 Eccentric "E" used to retrain fixation away from a central scotoma

- Next, the patient is instructed to practice looking away and then, back to the X.
- The patient should move the E left and right, while maintaining fixation on the X. If the E becomes blurred or out of focus, then the patient is instructed to place the E centrally and refixate on the X. The exercise is repeated, while moving the E up and down.
- Next, the patient must repeat the exercise with an E that does not have an X or lines to guide the patient to the eccentric viewing position.

6- Using other senses:

Using tactile and auditory sense for visually impaired with little or no residual acuity by using a combination of strategies such as high contrast, color contrast or relative size magnification.

Auditory: as the spoken word, the Talking newspaper, The RINB's Talking Books and Daily Living equipment incorporating an auditory stimulus for examples liquid level indicator, talking watches and clocks, talking tint, talking greeting card and talking microwaves (Fig 51).

Tactile: like Braille and Moon, national library for blind holds the largest source of books on loan. The RNIB also produce magazines, journals and cards with Braille tactile (Fig 52).

Figure 51 Liquid indicator and talking tins

Figure 52 Tactile reading by Braille

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Chapter 11

Environmental Modification in Vision Rehabilitation: Enhancing Independence and Safety

Environmental modifications (EMs) play a crucial role in vision rehabilitation, empowering individuals with vision loss to navigate their surroundings safely and independently. By adapting the environment, you can maximize remaining vision, minimize risks, and improve overall quality of life.

Key areas of focus:

Lighting:

- Increase illumination in key areas like walkways, stairs, and work surfaces.
- Utilize task lighting for specific activities.
- Minimize glare through proper lamp placement and window coverings.
- Consider color temperature (warmer tones can enhance visibility for some).

Contrast:

- Increase contrast between objects and their surroundings by using contrasting colors for walls, floors, and furniture.
- Mark edges of steps and countertops with high-contrast tape.
- Use brightly colored labels for frequently used items.

Clutter:

- Reduce clutter to create clear pathways and eliminate tripping hazards.
- Organize belongings in labeled and easily accessible locations.

Furniture:

- Arrange furniture to promote safe movement and clear circulation.
- Use stable and well-padded furniture with armrests for support.
- Remove scatter rugs that can cause falls.

Accessibility:

- Install grab bars in bathrooms and near other areas where support is needed.
- Widen doorways for easier access with assistive devices.
- Lower light switches and thermostats for easier reach.

Benefits of environmental modifications:

- Increased independence and ability to perform daily activities.
- Reduced risk of falls and injuries.
- Improved confidence and self-esteem.
- Enhanced sense of control and well-being.

Additional notes:

- It's essential to personalize EMs based on the individual's specific needs and visual limitations.
- Collaboration between occupational therapists, low vision specialists, and individuals with vision loss is crucial for successful implementation.
- Cost-effective solutions and DIY modifications can often be very effective.
- Regularly reassessing and adapting the environment as needs change is crucial for ongoing success.

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Chapter 12

Low vision in common eye disorders

There are certain diseases which are frequently seen in the low vision clinic. Different ocular diseases cause different visual disturbances and accordingly their management has to be decided.

Low vision is practically not defined by specific acuity limits. It includes any functional visual loss after proper medical or surgical treatment and correction of refractive error and presbyopia.

Always remember that there are different needs for each individual patient according to age, educational level, socio-economic status, and life style.

- Important notice: There are NO approved optical visual aids which can help patients to drive vehicles or walk freely without restrictions, because telescopes leads to smaller visual field, virtual closer image and distortion of depth perception.

The commonest causes of low vision and examples of Low vision rehabilitaion options are listed below.

Macular degeneration

In the early stages of macular degeneration, central vision is blurred and seeing at a distance or close work is difficult. The eye may still have good side vision, but black spots appear in the center. This makes reading or seeing faces difficult.

Visual effects (Fig 53):

1. Metamorphopsia.
2. Poor central vision but good side vision.
3. Central Scotomas, i.e, small areas of vision loss. The objects are seen when they fall on peripheral retina and disappeared when they fall within the blind spots.
4. Photophobia.
5. Comparatively better vision at night.
6. Colour perception is poor as highest concentration of cone cells are in the macula.
7. Depth perception is impaired.

Figure 53 Macular degeneration

Low vision aids and rehabilitation:

1. Monocular telescopes may be used in some cases to locate street signs and spotting general environmental clues.
2. Binocular telescopes for TV or board at school.
3. High plus near magnifying glasses (monocular or binocular prismatic)
4. Stand magnifiers in useful specially in wide areas of central vision loss.
5. CCTV & electronic magnifiers for reading.

6. Good lighting.
7. Use Strong colours and colour contrast.
8. Filters to reduce glare in sunlight.
9. Vision rehabilitation is required to promote eccentric viewing. Try looking at the objects from the side of eyes, not directly at them.

Retinitis pigmentosa

It is very common to see a RP patient in a low vision clinic. Most of these RP patients have mobility problems due to tubular fields. They may be able to read enough lines on the near and distance vision charts. Their disability can be dealt by environmental modifications that can help the person suffering from retinitis pigmentosa perform functional tasks.

<u>Visual effects (Fig 54):</u>

1. Difficulty in seeing at night or in poor illumination leading to night blindness.
2. Decreased visual acuity.
3. Photophobia.
4. Loss of peripheral field of vision, leading to tunnel vision.
5. Poor contrast sensitivity.
6. In later stage central vision may be affected due to macular damage.
7. Difficulty to adapt in changing illumination.

Figure 54 Retinitis pigmentosa

<u>Low vision aids and rehabilitation:</u>

1. *Management of peripheral field of vision:* Reverse Galilean telescope may be used but it reduces the visual acuity.
2. *Management of night blindness:* Night blindness may be dealt with increasing light levels inside and outside home.
3. *Management of light adaptation:* Amber filters of varying density. Hats and visors are often helpful and wrap-around sunglasses with side shields are helpful tools.
4. *Management of decreased central vision with loss of peripheral vision:* High contrast letters, CCTV or magnifiers may be applied on case-to-case basis.
5. *Vision Rehabilitation:* Apart from low vision aid some rehabilitation is also needed. For example, changes in walking speed and scanning the environment, introduction of long cane etc.

Glaucoma

Glaucoma is a leading cause of blindness. If it is diagnosed early, blindness is nearly always preventable. If uncontrolled it leads to several field defects and reduction in contrast acuity. Prognosis of improving with optical devices is bad if the field loss is extensive.

<u>Visual effects (Fig 55):</u>

1. Blurred vision which is gradual.
2. Haloes around the light.
3. Reduced peripheral vision.
4. Photophobia.

Figure 55 Glaucoma

<u>Low vision aids and rehabilitation:</u>

1. Magnifiers depending on the extent of field defect.
2. Filters to reduce glare.
3. Education and training of the patient to improve mobility in loss of field.

Albinism

People with albinism have pale or white skin and hair, and vision is poor. Near vision is usually better than distance vision. They can have nystagmus, refractive errors and subnormal visual acuity. Spectacles usually improve vision but do not give normal vision. Low vision devices can be useful for distance and are sometimes needed for near activities.

<u>Visual effects:</u>

1. Decreased visual acuity to 20/200 to 20/70.
2. Distance vision is more affected than near.
3. Painful photophobia.
4. Nystagmus.

5. May present with high refractive error with astigmatism.

<u>Low vision aids and rehabilitation:</u>

1. Visors or caps.
2. Dim illumination.
3. Coloured or pinhole type contact lens to prevent light passing through iris.
4. Dense sunglasses.
5. Absorptive filters.
6. Telescope for distance vision.
7. For reading work, place light over shoulder rather than in front.

High Myopia

One will come across such patients very often in low vision clinic. They are concerned about their deteriorating vision, which may start hampering their distance vision. Students with vision between 6/60 to 6/18 are mostly able to read blackboards from front bench. Their near vision is usually good without glasses, at the focal point. It is not wrong to do so, and they should be asked to read the fine print without glasses. This is just like adding high plus to their distance correction. A magnifier is also useful for small print reading for short intervals.

In cases of myopic degeneration, telescopes may be helpful in distance vision on the condition that the myopia is corrected by contact lens or clear lens extraction or telescope mounted over their glasses.

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