REHABILITATIVE PROCESS OF LOW VISION PATIENTS: ENVIRONMENTAL MODIFICATION

AUTHORS

Joseph Cho: The Hong Kong Society for the Blind

Pirindhavellie Govender: University of KwaZulu Natal (UKZN)

PEER REVIEWER

Dennis Siemsen: Mayo Clinic

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AIMS

This module aims to outline the ways and means to modify the environment of a low vision patient via developing an:

- Understanding of the role of magnification
- Understanding of the role of colour and contrast
- Understanding of the role of design

LEARNING OUTCOMES

After completing this module, students should be able to:

- Analyse the role that various environmental factors play in the functional ability of a person with low vision
- Determine the optimum internal and external design characteristics that improve the functional ability of a person with low vision

INTRODUCTION

ENVIRONMENTAL FACTORS THAT AFFECT THE PERFORMANCE OF A PERSON WITH LOW VISION

Patients with low vision can achieve substantial gains in functional ability with environmental modifications. Making a private or public environment both functional and comfortable for people with low vision should be standard practice that will benefit all users of that building, whether it is a home, a workplace, a museum, a senior centre, or a home.

Having a safe and accessible environment for people with low vision does not necessarily require a lot of time, energy, or money, but rather knowing the basics and planning for easy access.

The modifications that can be made involve size, distance, colour, lighting, glare and contrast. Environmental modifications are best achieved by site visits to the patient's environment (if possible) and providing education to the patient on various ways in which he/she can optimize lighting and contrast and prevent glare. Environmental modifications should ideally be considered at two levels i.e. in the individual's general environment and in specific tasks performed within the environment. Simple home modifications can have significant effects on the patient's quality of life. In addition, the use of sensory substitution, i.e. tactile or auditory assistive devices can offer the patient a greater level of security within their environment in the absence of visual cues.

SIZE MODIFICATIONS

Size modifications are based on the simple optical principle of relative size magnification.

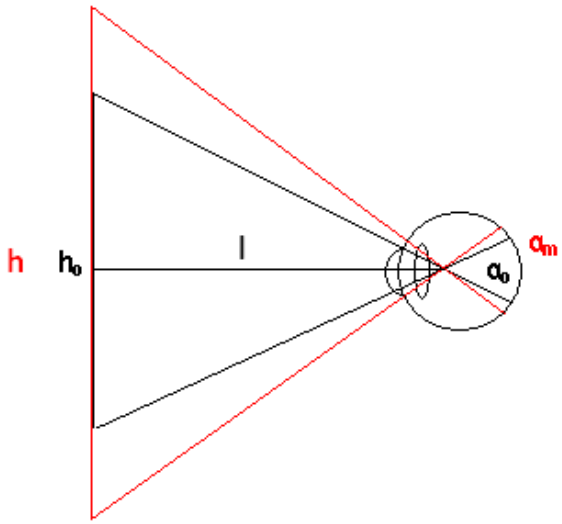

Figure 1: Graphical representation changes in the image size with an increase in object size

Figure 1 illustrates the increase in retinal image size with an increase in the size of the object. Applying this to environmental modifications, the diagram illustrates that a physical enlargement of the object produces an enlargement of the retinal image. This concept is observed in the use of large print books, large print cards, larger clocks, calculators, etc.

DISTANCE MODIFICATIONS

Distance modifications are based on the simple optical principle of relative distance magnification.

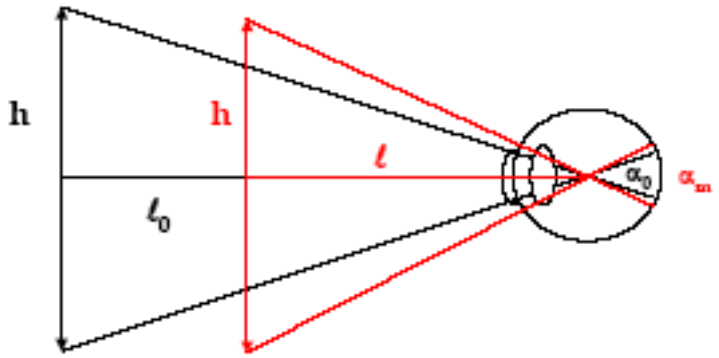

Figure 2: Graphical representation changes in the image size with a decrease in object distance

Figure 2 illustrates the increase in retinal image size with a decrease in the distance from the object. Applying this to environmental modifications, the diagram illustrates that a decrease of the distance between the individual and the object is able to produce an enlargement of the retinal image. A simple way of explaining this to a patient is to tell them that should they wish to see something larger, they should get closer to it, e.g. a patient having a problem reading the subtitles on television should be able to discern the letter better by moving closer to the screen.

COLOUR

Patients with low vision may have difficulties distinguishing subtle differences between colours. Their keen sense of difference between colours can be used to enhance their safety in the general environment. The difference in colour may enable accessibility thereby making it easier for them to engage in their daily living regular activities.

Bright colours can be useful for many visually impaired persons, but the contrast between the object and the background must be considered, as some vision conditions can make a scene that looks good to a sighted person be very difficult to see for a person with low vision.

- Bright colours reflect more light and are therefore easier to see e.g. bright colours on elevator buttons or light switches
- Solid bright colours are more saturated and therefore easier to see than diluted colours (pastels)
- A walkway painted on the floor for incoming/outgoing traffic
- Bright colour cards attached to hangers indicating a specific colour code. Labels can also be attached to clothing to match colours.
- Bright light, appropriately applied, enhances colour perception while dim light causes some colours to appear “washed-out”
- The role of colour in safety cues is especially important

- Warning of hazards
- Indicating change in surface or level, like that of the bright yellow stripe at the leading edge of a step
- Colour combinations and contrast, e.g. white or bright yellow against black or blue backgrounds (or the reverse) appears better than e.g. red on grey etc.

LIGHTING

Appropriate modification of the level of lighting varies from person to person when optimizing visual performance. Different causes of low vision result in different sensitivities to light compared to individuals with no eye disease. Patients with the same eye disease however, don't necessarily display the same response to a given level of light. When considering lighting modifications in low vision patients, we are concerned with two aspects i.e. the amount of light (brightness) and the level of glare produced.

1. Amount of light (i.e. the level of illumination) must be adequate: Sometimes increasing the amount of light can also result in glare (Fig. 3). Patients with low vision as a result of diseases of the retina or neural transmission are less likely to benefit from lighting modifications, however, patients with disease affecting the media tend to experience greater benefit due to the reduction in glare obtained with a reduction in lighting levels. While this may be the case, adjustable lighting levels are always advised since one is unable to predict the individual's response to changes in lighting levels.

Figure 3: Increased level of illumination creating glare and decreasing visibility of targets

2. Remove glare: There are various ways in which we can reduce the level of glare e.g. ensuring the light source is directional, shading the light source and directing the light source from the side. Light sources that are placed above or behind a target tend to reflect off the material being viewed.

Figure 4: Effect of reduction in direct glare on the visibility of the target

3. Prevent reflection: Excessive light or reflections have a tendency to produce discomfort glare. This results in a decrease in vision and it has a tendency to be distracting to the viewer.

Figure 5: Effect of reflection on surfaces

4. Uniform distribution of light:

Figure 6: Providing uniform distribution of light in a room

5. Task lighting with adjustable intensity, distance and angle of projection:

Figure 7: Providing light sources with variations in distance and angle of projection

Eye disease	Preferred lighting	Sensitivity to light
Cataract	High	High
Diabetic retinopathy	Moderate	Moderate
Glaucoma	Moderate	Moderate
Macular degeneration	Varies usually brighter	High
Retinitis pigmentosa	Moderate to bright	High

Table 1: Lighting requirements and light sensitivity for clients with common eye diseases

Source: Lueck AH. Functional vision: a practitioner's guide to evaluation and intervention, New York. AFB Press; 2004

While Table 1 indicates the lighting preferences for most low vision patients, it should be noted that many low vision patients will determine their lighting requirements by trial and error and therefore the information in the table remains a guideline.

The modification of lighting can be determined by the **Inverse square law**.

$$l = \frac{1}{d^2}$$

Where: l = intensity of light
d = distance from light source to working surface.

The equation translates to the fact that if the eyecare practitioner wishes to increase the intensity of the light source, he/she need merely move the light source to half of its previous distance in order to increase the intensity by 4 times. This approach is sometimes more practical and cost effective than replacing the light source to one of greater wattage.

Type of light	Advantages	Disadvantages
Natural light	▪ Most natural type of light ▪ Appropriate for many tasks	▪ Inconsistent ▪ Creates glare ▪ Creates shadows ▪ Changes throughout the day ▪ Limited adjustability
Incandescent	▪ Readily available in a large variety of wattages ▪ Light is concentrated ▪ Better for "spot lighting" on near tasks ▪ Light does not "flicker" like fluorescent light	▪ Not recommended for general room lighting ▪ Can create shadows and glare ▪ As wattage increases, heat also increases ▪ Becoming unavailable ▪ High energy consumption
Fluorescent	▪ Better for general room lighting ▪ Illuminates a wider area than incandescent light ▪ Does not create shadows ▪ Cooler than incandescent ▪ New compact fluorescent bulbs fit into regular lamp sockets with less heat and use less energy ▪ Many colour temperatures available	▪ Light is not stable; can flicker ▪ Can't be dimmed as easily as incandescent light
Combination incandescent and fluorescent	▪ Can be combined to create a comfortable environment ▪ Approximates natural light ▪ Some lamps come in socket for both types of bulbs	▪ May require the purchase of additional lamps ▪ Specialized lighting fixtures can be expensive
Halogen	▪ Brighter than incandescent light ▪ Gives more illumination and uses lower wattage ▪ More energy-efficient than regular incandescent light bulbs	▪ Light is hotter, more focused, and requires a shield. ▪ Not recommended for prolonged close work ▪ Bulbs need to be replaced frequently and are more expensive than comparable incandescent lights ▪ May be dangerous for low vision patients because of the potential for burns

LED lights	▪ High efficiency ▪ Do not produce external heat ▪ Very long lifetime ▪ Available in many colours	▪ Can be expensive

Table 2: Types of lighting and their relative advantages and disadvantages

(Source: Scheiman M et al. 2007. Low Vision Rehabilitation: A practical guide for occupational therapists. Slack Incorporated, USA.)

GLARE

Glare can be described in three ways i.e. disability, discomfort and environmental glare.

- **Disability glare:** arises from problems with the ocular media like the cornea or lens. The media opacification can cause light passing through to scatter, thereby producing distortion of the retinal image.
- **Discomfort glare:** refers to stray light that reduces visual comfort, however, does not affect the quality of the retinal image. An example suggested by Corn and Koenig is "a student whose desktop reflects the ceiling lights may experience visual fatigue when working on materials placed on the desktop".
- **Environmental glare:** refers to glare which results in poor resolution of the retinal image. It may be caused by glossy pages or particles in the air or on the viewing surface.

GLARE MODIFICATIONS

Change environment or working surfaces to those which have light-absorbing properties as opposed to light-reflecting properties. These modifications can take on the form of:

- Decrease objects suspended from the ceiling
- Place a carpet remnant underneath a workstation
- Use a desktop blotter
- Use a cap with a visor

(Source: Corn AL and Koenig AJ. 1996. Foundations of low vision: Clinical and functional perspectives. AFB Press, USA)

SIGNS AND NOTICES

Signs and notices should be designed with the following criteria in mind;

- Size
- Simple and easy to understand
- Contrasted with the background
- Colour (hue, saturation and brightness)
- Shape
- Position at eye level and non-reflective
- Consistency to reduce confusion (uniform in basic layout/design, colour and typeface, etc.)

Figure 8: Bathroom signs not sensitive to patients with low vision

Figure 9: Bathroom signs that display better contrast and size

Figure 10: Well-contrasted signs

INTERIOR DESIGN

ENTRANCE

1. The width of an entrance door should be sufficiently wide for a person with severe visual impairment plus a sighted escort.
2. Automatic sliding doors must have distinctive warning strips on door, or decorative patterns or information sign at children and adults' eye levels.
3. Use colour or images or appliques to distinguish between the doors and sidelights

Figure 11: Distinctive warning strips/decorative patterns on sliding doors

ACCESS: STAIRCASES

1. Staircases should bear high contrast nosing and handrails should also be well contrasted against walls on a staircase

Figure 12: High contrast nosing and hand rails outdoors

Figure 13: High contrast nosing indoors

RECEPTION AREA

1. Building directory: should have high contrast as well as large enough print so that visually impaired persons can read the signs adequately.

Figure 14: A high contrast building directory

2. Floor layout plan with audio description can be particularly useful to a person with low vision.

Figure 15: Tactile floor layout with audio descriptions and Braille

3. Placing a directory and map closer to the reception counter can aid the low vision patient in gaining perspective of where things are located relative to his/her existing position. Braille is useful for individuals who are blind.

Figure 16: Tactile map with Braille

MAIN CIRCULATION AREA

1. The main circulation area for any area should be free of obstacles thereby enabling free movement
2. Essential facilities should be grouped into one area
3. Areas of different functions should be distinguished by different floor coverings, furniture and light fittings, and different colour schemes

4. Patterned “walkways” should be created for ease of access and identification.

Figure 17: Floor coverings in long aisles and clearly marked walkways

CORRIDOR AREAS

1. Doors along corridors should be opened into the rooms with door surface, door rim, handle and key having good contrast with each other (Fig 18 and 19)
2. Projecting signs to help the low vision person to locate rooms at a further distance
3. Any changes in level in walkways should be highlighted
4. Floor finishes should be matte and non-reflective, and have contrast with the walls to indicate their boundaries (Fig 20).

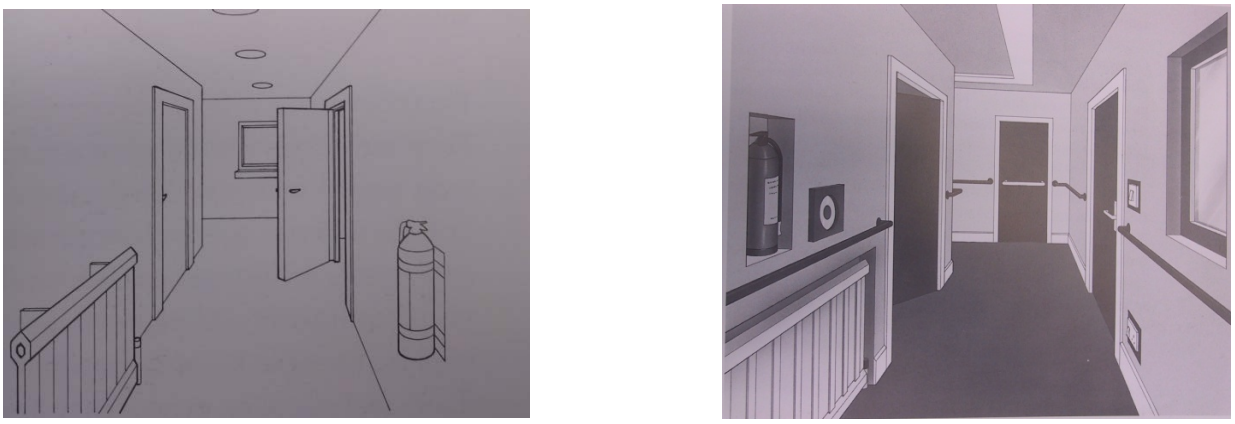

Figure 18: Corridor with poor contrast and doors opening into corridors versus a corridor with good contrast

Figure 19: A well-demarcated and contrasted door

Figure 20: A well-contrasted corridor (although the seating creates a mobility hazard)

EXTERIOR DESIGN

STREET FURNITURE

- Signposts, lighting columns, litter bins and seating should be out of the line of pedestrian travel and contrast against the background with a different colour band at eye levels, or strips.

Figure 21: A well-contrasted walkway with light posts

VEGETATION

- Vegetation is good in open space where there is more room to move about; well away from the curb to act as a boundary indication; fragrance, colour and shape can help as landmarks for orientation for patients as well.

Figure 22: Placement of vegetation as boundary indicators

OPEN SPACE

- High contrast guide path

Figure 23: Placement of tactile tile as path indicators

OTHER ENVIRONMENTAL DESIGN THAT CAN AID ORIENTATION AND TRAVEL

1. Electronic card readers can give audible feedback for travel or other money transactions (Fig 24).

Figure 24: Octopus reader

2. Tactile map with audio device can give audio description about what services and facilities are available in the areas shown on the maps (Fig 25)

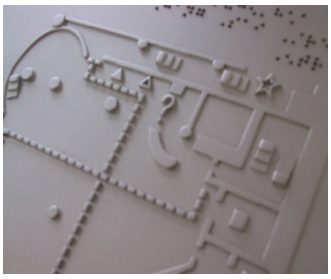

Figure 25: Tactile map

ENVIRONMENTAL DESIGNS TO AID ORIENTATION AND TRAVEL

1. Buses – letters are sometimes too small on the information display
2. Information Counters – are sometimes not located at the most convenient spot
3. Train Station – guide paths only lead to one instead of all the train compartments
4. Lack of guide paths to counters, ticket offices, wrong guide path routes, poor contrast of guide path, etc.

HOW TO SOLVE THESE PROBLEMS

- Regular inspection should be carried out by users and organizations for and of the visually impaired.
- A working group should be formed and should include representatives from the tourism board, building department, architectural services departments and transportation departments for enacting the required improvements.
- Regular public educational programs should be carried out to promote the need for barrier-free facilities for the disabled.

POSSIBLE FUTURE DEVICES THAT WOULD GIVE MORE MOBILITY FREEDOM TO PERSONS WITH VISUAL IMPAIRMENT

Outdoor

- Infrared transmission system
- Satellite navigation system, global positioning system
- Universal mobile telecommunication system
- Vision substitution

Indoor

- Talking sign post
- Easy Walker

GOVERNMENT POLICY

Examples of obligatory requirements:

- Tactile maps
- Tactile guide paths
- Tactile signs for toilets

Some recommended designs:

- Signs should be of contrasting tone to its background with raised characters
- Minimum luminous contrast of 30%
- Specified minimum illumination levels for different situations

- Lift buttons in keypad arrangement (Fig 26)

Figure 26: Lift buttons in keypad form

- High contrast nosing for pedestrian subway and footbridge

Figure 27: Handrail with braille indicators and braille plates

Figure 28: Warning strips to every drop curb

GOVERNMENT POLICY DEPENDS ON:

- Public awareness and support of the need for equal opportunity in free access for the visually disabled
- Educational and publicity promotions organized by associations and organizations of and for the visually impaired with relevant government departments.
- Active participation of persons with visual impairment in social activities
- The growing in the number of low vision persons with the increase in the elderly population.

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- Corn AL and Koenig AJ. 1996. Foundations of low vision: Clinical and functional perspectives. AFB Press, USA
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