The MoviText method: Efficient pre-optical reading training in persons with central visual field loss

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Abstract. The MoviText method has been developed and tested on individuals with absolute central scotomas as a pre-optical reading training method. The ZoomText computer screen magnification software with its DocReader feature has been used in reading training to show the effect of moving the text during reading. The user reads with his or her selected eccentric angle viewing in order to acquire the new eccentric reading behavior more easily, before optical devices are introduced. Nine subjects in this study used microscopic lenses from 6X to 13X magnification as reading devices. The subjects, all with very large central visual field losses, achieved a significant improvement in reading rate when using the microscopic lenses after training with the new MoviText method.

Keywords: Central visual field loss (CFL), preferred retinal locus (PRL), eccentric viewing, microscopic lenses, pre-optical reading training

1. Introduction

People with normal vision read with short, rapid saccadic eye movements, intermingled with short stops called fixations. These fixations encompass a fixation field; the bigger the field, the greater the number of letters that can be decoded at the same time. The fewer fixations when reading, the faster we can read because the greater part of reading time is used for fixations [14]. Eye movements include saccades between the fixations and return movements when changing lines. Regression movements are when we go back in the text and re-read parts because we have not understood the contents. Normal reading techniques are based on a person being able to use the extremely good resolution of the macula, making it possible to resolve details such as graphic characters.

In the case of central visual field loss (CFL), there are great discrepancies in the awareness and training levels of people with CFL in how to optimally utilize their eccentric viewing [7,17]. The location outside of the macula for eccentric viewing is called the preferred retinal locus (PRL) and can vary for many people with low vision depending on the visual task. Persons with CFL are not always aware of how to find their PRL, even when they have had their impairment for a long time [16].

It is generally assumed that the entire macula is damaged when visual acuity in decimal notations is under 0.1 (20/200 or 6/60). This means that you cannot read using normal reading techniques, but instead need to use magnification devices and eccentric viewing. Training in the use of special eye movements and strategies is also necessary [1]. In order to make use of residual vision with microscopic lenses in cases of CFL, one has to utilize eccentric viewing. This means using other parts of the retina outside of the macula to see details. Due to the lower density of cones outside of the macula, smaller objects and details need to be magnified in order to achieve resolution.
There are at least three methods for utilizing the residual vision outside of the macula:

– Projection magnification. The easy way to read is by magnifying the image considerably on a screen with a Closed Circuit TeleVision (CCTV) system, or a software program in a computer.

– Relative distance magnification. This involves placing the material close to the eye, often only a few centimeters away. In adults this requires that the accommodation is facilitated by optical devices that have a strong, positive effect – microscopic lenses. The distance determines the magnification and the lenses provide acuity and a certain image magnifying effect. Magnification is calculated by the formula D/4: +40D, for example, results in a magnification of 10x.

– Angle magnification. Telescopic systems at lower levels of magnification can be an alternative for increasing the reading distance. The reduced visual field at higher levels of magnification in this kind of system compared with microscopic lenses can result in difficulties in using the peripheral vision optimally.

1.1. Reading eccentrically

Several articles have described what you need to do in order to place the image in a new area of the retina outside of the damaged part [3,4,10]. The new localization is called PRL. When training a new PRL, it is referred to as a trained retinal locus (TRL) [12]. The most appropriate location outside of the damaged area is determined by using perimetry evaluation and the subject’s own preference. Thereafter, the subject practices using his or her PRL.

When reading, the subject fixates above, below or to the side of the text. The subject moves the text from right to left in front of the selected eye with the optical device, maintaining the same focal distance. This is accomplished by keeping both elbows on the table and holding the text with both hands while moving it in front of the eye with the microscopic lens. By moving the text and asking the patient to keep the eye at a fixed eccentric viewing angle, which places the text as close to the central scotoma as possible, it is possible for the subject to read if, and at the same, keep the scotoma from falling into the text. While reading with this method the eye will move at the same speed along with the moving text in a “sliding fixation movement” which the patient is often not aware of.

In order to utilize PRL optimally, fixation lines have been employed since the 1970s, making it possible to consciously control the eccentric viewing [1]. The magnified text or image then falls on the selected PRL. Several researchers have subsequently refined these methods and techniques by using the Scanning Laser Ophthalmoscope (SLO) [4,5,13]. SLO has the advantage of allowing you to see where the text is placed on the retina. With SLO there are also techniques that make it possible to display text that moves from right to left on the retina at the PRL [4,6]. The SLO technique is very attractive but has proven to be expensive and difficult to use when training eccentric viewing in clinical settings in low vision rehabilitation.

The effects achieved by the methods just described, that of a horizontally moved text with fixation lines and SLO with horizontally scrolled text, are similar and in both cases movement resolution in the peripheral part of the retina is used in a positive way [6].

1.2. PRL – one or several locations on the retina

One study reports that a significant minority (39%) of the subjects with CFL chose two or more PRLs for eccentric viewing. Several PRLs were common in cases of large central scotomas, particularly if the scotoma was greater than 20 degrees [17]. In the Widesight Project [8], in which the current study is included, several subjects are described who have different PRLs depending on the visual task. One PRL was used to read printed material, another for orientation and overview and a third for watching TV and reading on computer screens. One reason for the multiple PRLs is that reading requires a large horizontal fixation field rather than good visual acuity, which can be compensated for with magnification. When reading selectively, a smaller indentation in a central scotoma is sometimes preferred for spot reading page numbers, prices, etc. When seeing at a distance, a very large visual field is important for obtaining an overview, while identification requires another fixation with better visual acuity [8].

Low vision people often do not seem to be aware of how they should fixate eccentrically in order to see optimally; they have not received information and training to the extent needed to learn the technique in order to achieve the best functionality [15,16]. Learning the technique is not always a spontaneous process if the visual impairment is acquired as an adult [9].
1.3. Purpose and need

Based on the problems of learning eccentric viewing efficiently, the MoviText Project tried to create a model to see if it was possible to develop a methodology in which the testing of microscopic lenses, eccentric angles (PRLs) and eccentric viewing training were included. Using this methodology, you are able to analyze how the ability to read improves over the three sessions that are described in this article. Size and location of the scotoma vary in persons with large CFLs. There can also be considerable variations in visual acuity and contrast sensitivity. Consequently, it is difficult to find a comparable control group. The differences between the groups make it difficult to draw any significant conclusions from the resulting data. Hence, we chose not to use a control group.

Since people are living longer, the number of cases with CFL due to age-related macular degeneration (AMD) is increasing, which is another reason why this work is significant. Even though some cases of AMD can be treated medically to stop deterioration, there will still be a considerable number of people in the future with absolute CFL. Only 15% of all the people who have AMD have the wet, treatable form. In 1997, the World Health Organization (WHO) estimated that close to 8 million people worldwide are visually impaired due to macular degeneration.

2. Materials and methods

This research is a part of the larger Widesight Project, which has been underway for several years and has evolved into the Low Vision Enabling Laboratory in Lund, Sweden. The main research in the Widesight project is involved in evaluation of optical aberrations created when using eccentric viewing, due to CFL. The optical measurements is performed with fotorefraktion and wavefront technology methods. Obtained corrections used are called “eccentric corrections” and vary individually due to used PRL. More information is available on www.certec.lth.se/lve.

2.1. Pre-optical reading method

When training eccentric viewing with microscopic lenses, the patient has to learn how to handle his or her optical device with an extremely short reading distance. The fixatation lines (Fig. 1), help the subject to hold the scotoma above or below the line of text [1]. In this work we have tried to find a complementary, more efficient “pre-optical method” for training eccentric viewing when reading. The method is based on the ability to read a magnified and moving text from start to finish with the text displayed on the screen from right to left at variable speeds. Reading with MoviText is similar to reading with microscopic lenses in relation to eccentric viewing. When training in front of the screen reading the scrolled text you chose your eccentric viewing angle from the eight alternatives given and keep the head still.

After an analysis of the commercially available programs, most of the functions needed for our purposes could be found in the DocReader feature in ZoomText version 5.1.

The moving text in ZoomText’s DocReader provided the name for the method we describe here, MoviText. Figure 2 shows how it is presented on a computer screen. The MoviText module allows you to display the text so as to artificially achieve a horizontally scrolled text without having to move it yourself and without using “optical magnification”. With eye correction (when needed) for refractive errors, people can easily practice using their best eccentric viewing angle for reading, their PRL.

2.2. Choice of optical magnification

In order to minimize the problems with aberrations that arise from using microscopic lenses, the ML–A2 lens system was chosen, manufactured by Multilens in Sweden. This is an aplanatic lens system which contains two plano-convex lenses with the convex surfaces arranged face-to-face and mounted in a conical tube, which is placed in a spectacle frame monocularly in front of the eye that is used for reading.
Fig. 2. The computer screen used with ZoomText and the DocReader function in Ticker Mode. The different fixation alternatives are marked with an X.

Fig. 3. The aplanatic (2 plano convex lenses, face to face) microscopic system A2 used in this study.

The aberrations, such as distortion and astigmatism, are significantly reduced in a two-lens system compared to the more commonly used single lenses. Aberrations in single lenses are especially inconvenient for persons using eccentric viewing as they move the text in front of the lens from right to left. The wavy appearance of the text during reading is both tiring and feelings of motion sickness can occur. Because the used two-lens system has super antireflection coatings on all surfaces, the image is also very bright.

3. Subjects

Subjects for the study were selected from a group of about 60 persons with CFLs that were part of the Widesight Project. They have contacted us almost exclusively through Sweden’s 35 low vision centers. Of the twelve subjects that made up the initial group, nine completed the entire study. The three who dropped out had visual impairments similar to the remaining nine and stopped because of external reasons such as lack of time.

The subjects were selected according to the following criteria:

– A visual impairment in the 20- to 80-year-age group with an absolute central scotoma, (see Fig. 4) and decimal visual acuity lower than 0.1 (20/200 or 6/60).
– Normal optical media and movements of the eyes.
– High motivation for demanding training.

All of the subjects gave their permission in accordance with the Helsingfors Convention, approved by the local ethical boards.

Nine subjects completed all parts of the examination and training method, three men and six women, from 33 to 81 years of age with an average of 45.8 years. The causes of their visual impairments were AMD in two persons, Stargart’s disease or other similar congenital retinal disease in two persons, Leber’s Opticus Atrophy in three persons, and one person with CFL after uveitis, and one with CFL from a post operative tumor in the visual paths. All of the subjects have received a range of services from low vision centers and six have also received vocational rehabilitation services for the visually impaired.

Visual acuity among the subjects varied from 0.16 to 0.03 in decimal acuity (20/125–20/700) (see Fig. 5). It became apparent during training that the subject with a visual acuity of 0.16 (20/125) did not have a total CFL. If that subject is removed, the subject with the best-corrected visual acuity is the one with 0.08 (20/250). The number of years subjects have been visually impaired varied from 3 to 21 years (see Fig. 6). Of the 9 subjects, only 3 had microscopic lenses previously: cases 4, 8 and 9.

3.1. Summary of steps in the project

The MoviText method is performed during three different sessions. Every session lasted one hour. The interval between sessions was 2–3 weeks. The reading tests that were administered in the three sessions can be found in the training material in Low Vision Training (Bäckman & Inde, 1979) and were moderately difficult in content. They consisted of three-minute assessments of reading rate.

Session I:

1. The low vision optometrist prescribed microscopic lens
2. The low vision therapist provided information on the visual impairment and MoviText
Fig. 4. Goldman perimetry diagram of one of the typical subjects.

Session II:
3. Fitting of microscopic lens system
4. Reading rate test A
5. Finding the angle of eccentric viewing with Movi-Text
6. Reading training with MoviText and fixation lines
7. Reading rate test B
8. Training at home

Session III:
9. Reading rate test C
10. Reading training with MoviText and fixation lines
11. Reading rate test D

3.2. Session I

3.2.1. Low vision assessment and correction
A low vision assessment was administered to the subjects by an experienced low vision optometrist. The eye with the best visual acuity was used and the magnification level established as the level at which the subject could read text that was two print size smaller than the acuity threshold needed. The poorer eye was equipped with different types of occlusion if the subject had experience using it or if the occlusion provided better comfort and less interference. All the subjects used the ML-A2 aplastic lens system to get a good image quality on the retina. Magnification needs varied between 6 and 13X (+24 – +52 diopters) measured in effective magnification on the retina. All the subjects were prescribed microscopic lenses for reading. The lenses were placed in frames resulting in a very short reading distance related to the lens powers described above.

3.2.2. Training with a low vision therapist
In the second part of the initial visit, the subject met a low vision therapist with many years of experience in low vision rehabilitation and reading training. A structured discussion provided information on the following issues:
The subjects related their experiences of previous optical devices and CCTV reading. In addition, the principles of the MoviText methodology were described to them. The primary goal was to get a case history, establish rapport and determine needs and possibilities for continued training and device usage.

3.3. Session II

The optometrist carried out adjustments, fittings and assessed how well the microscopic lenses functioned for reading before reading training with the low vision therapist began.

3.3.1. Reading rate test A

Reading for three minutes of a moderately difficult text with the new microscopic lens without training.

Reading training with MoviText, on the computer screen without the microscopic lens, in which the following variables were adjusted and measured individually: linear magnification, distance from the screen, scrolling rate and light intensity on the screen.

The scrolled text in the ZoomText program (DocReader module) can be exposed at various reading speeds. The reading speed chosen for the subject was equivalent to the most comfortable one for each individual. The size of the text was measured in linear magnification on the screen, correlating to a reading distance of 40 cm. The linear magnifications ranged from 4 to 16X. The effective magnification was calculated as follows:

\[ EM = 40 \times \frac{LM}{RD} \]

\[ EM = \text{effective magnification on the retina} \]
\[ LM = \text{linear magnification on the screen} \]
\[ RD = \text{reading distance between the screen and the eyes} \]

Eight fixation alternatives were tested: to the right and to the left of the scrolled text, above to the left,
above in the middle, above to the right and the same corresponding positions of the last three below the text on the screen. In Fig. 3, the fixation directions are marked on the computer screen. The selected fixation was compared with the expected PRL based on the visual field diagram and (if it deviated) the previously selected eccentric viewing.

The subject was asked to adjust his or her preferred eccentric viewing angle in relation to the moving text. At this point, neither magnification lenses nor other types of correction were used in any of the cases.

Two texts were used in MoviText training. On the first occasion it was a very easy text with a low readability index corresponding to a fairy tale for children. It had short words, simple sentence structure and was easy to understand. The second text was an academic description with a high readability index and several long words, interspersed with Latin and English expressions so that the reader had to work at understanding the contents. The easy text was used when the subject adjusted his or her PRL for reading and when having problems reading eccentrically due to low visual acuity. When the subject grew accustomed to reading with the technology, he or she shifted over to reading the more advanced text to see if the eccentric reading technique worked when the content required concentration and a high level of comprehension.

After this, there was more reading training with microscopic lenses and with fixation lines using exercises from the Low Vision Training book [1]. The same PRL that was used in the MoviText training on the screen was used here.

3.3.2. Reading rate test B

The session ended with a three-minute long reading rate test, using the microscope lens with a text that was similar to that of reading test A from material in Low Vision Training.

3.3.3. Training at home

The subjects were encouraged to continue reading using their microscopic lenses after the second session. The majority of the participants had ZoomText in their home computers or at work, which is why they also had access to the MoviText method and, to varying degrees, could use it when training outside of the clinic.
3.4. **Session III**

3.4.1. **Reading rate test C**

The session began with a three-minute long reading rate test from the Low Vision Training book with microscopic lenses.

After test administration, the low vision therapist and the subject carried out exercises similar to those of the second session, alternating between training with MoviText and reading with lenses and fixation lines.

3.4.2. **Reading rate test D**

The session concluded with the administration of the fourth reading rate test for three minutes with microscopic lenses.

4. **Results**

The most important result is that the nine subjects achieved a significant improvement in reading rate when using the microscopic lenses after training with the MoviText method.

The need for magnification in microscopic lenses varied from 6X (+24 diopters) to 13X (+52 diopters) (see Fig. 7). Magnification need is not always correlated to the visual acuity. The directions of the eccentric viewing used were: three subjects fixated to the right and one subject to the left of the scrolled text, three subjects straight up and two subjects up to the right. The angle of eccentric viewing used was in relation to the eye’s optical axis, from 6 degrees out to 22 degrees.

The improved results in reading rate after training with the MoviText method can be seen in Fig. 8 for each individual. Some have improved slightly, but for the group as a whole, the improvement is clearly significant as measured by the Wilcoxin Signed Rank Test, p-value 0.012. Time for training with the microscope at home varied from 2–30 hours in 8 of subjects. The average training time at home was approximately 10 hours. In subject number 5 training at home was not possible due to low visual function.

Table 1 shows all the reading rate data from the reading tests and the improvement in reading rate in words per minute between reading rate tests A, B, C
Table 1

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<th>C</th>
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5. Discussion

This study reports a significant improvement in reading rate after only three training sessions, which included optical assessment and low vision training with the MoviText method. The material is not very extensive, but it still shows that structured reading training with optimal optical correction and a functioning educational method results in an increased reading rate after relatively limited efforts. For a few of the subjects, it has provided better reading function and made it possible for them to read in many more situations, while others have achieved a reading rate with correction that obviously can compete with other reading media, particularly CCTV systems. Increasing one’s reading rate from 25 words/minute to 116 is a large improvement and is most likely the result of being trained in using a better device with appropriate magnification. But increasing one’s reading rate from 30 to 69 words/minute is, without a doubt, of great value in daily living, even if the improvement is less dramatic. For the people with CFL in this small study, there is an optimal reading ability between 100 and 110 words/min. Most of the subjects were highly motivated and this, of course,
can have positively influenced the results. The lack of a control group can also appear to be a problem in this study. As it was stated in the introduction, we believe that it is impossible to find a similar control group, and therefore, it would have been pointless to try. It can also be argued that the subjects and the results may have been influenced by other variables. Still, the results show that this method can be a valuable contribution to the field of low vision rehabilitation.

Reading with eccentric viewing with CFL is a known phenomenon and has been used by many for a good while now. It has also been demonstrated that many visually impaired persons do not find their optimal PRL for reading outside of the central scotoma and that they are unaware of the technological possibilities. If this is the case, professional help can be needed in finding, maintaining and training a person’s PRL for reading in order to achieve the best reading function [8,18]. The MoviText method in this situation can be a useful instrument and a supplement to previous experiences.

Some groups of researchers have used and are still using SLO to find the best PRL and also in training eccentric viewing [4–6,8,13]. In normal clinical practice at low vision centers, it is often impossible to make use of this instrument. An alternative can be the easy to handle MoviText method presented in this study. The disadvantage, of course, is that the image from the fundus is not visible and you are not able to see where on the retina a person is reading, as can be done with SLO.

This study indicates that the process can be simplified, shorten the learning time and improve the outcome. It also offers a simple strategy for training with horizontally scrolled text without optical correction on a computer as a start, and later transferring this technique to manually moved horizontal texts with microscopic lenses and a short reading distance. This makes it easier and more motivating to prescribe and adjust microscopic lenses to a greater extent as a supplement to projection magnification with CCTV and computers.

Based on the results of this study, we conclude that reading with horizontally scrolled text is facilitated by the MoviText approach and that the application is considerably improved when used with microscopic lenses which provide high quality reproduction. As a result of good optical reproduction, the text that moves in front of the eye does not create unpleasant undulations.

The need for magnification in microscopic lenses varied from 6X (+24D) to 13X (+52) (see Fig. 5). When you compare acuity and magnification needs, you see that a lower acuity does not always result in a higher need for magnification in order to read with microscopic lenses and eccentric viewing. This can be due to the subject placing the PRL further out, i.e., not exactly on the edge of the scotoma [11] where the visual acuity is measured.

An additional effect is that some people in this limited selection, in spite of having very little residual vision, were able to profit from reading with eccentric viewing with microscopic lenses. With a visual acuity of only 0.03 (20/700) and a central scotoma of up to 20–25 degrees from the visual axis, they were able to read with 12–15X magnification at a reading distance of 1–2 cm. Some people in the study had not previously tested this kind of assistive technology even though they had received extensive low vision rehabilitation. This, of itself, can in some cases be the greatest reason for measuring the improvements. Other subjects have previously used very strong positive lenses (microscopic), but were disturbed by aberrations. They better tolerated the aplanatic system used in this study because it has a larger visual field and is devoid of “undulations” when using horizontally scrolled texts. It also offers greater contrast because antireflect treatment is present on all the four optional surfaces in the system.

A person reading scrolled text will move their eyes with the text, effectively stabilizing the image on the retina. When reading from a horizontally scrolled text, the movement acuity in the periphery of the retina is much better utilized [2]. The results reported here, as well as other tests that have been carried out, indicate that people with absolute CFL are best suited for detecting and seeing moving objects.

The obvious improvements in reading rate that this study reports can, to a certain extent, be explained by new insight and awareness of the problems on the part of the subjects, but we are convinced that in most cases it still is a matter of actual improvement. This also corresponds well to the reported subjective experiences of the people who participated in the study.

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References


