Evaluating the Effectiveness of an Established Community-Based Eccentric Viewing Rehabilitation Training Model—the EValuation Study

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Purpose. This study evaluated the community-based eccentric viewing (EV) training offered across the United Kingdom by the Macular Society. Volunteer trainers deliver free one-to-one training, usually in learners' homes. They also share information about lighting, magnification, social support, and low-vision technology.

Methods. The audio-recorded reading performance of learners was compared before and after training. Telephone questionnaires were used to assess life satisfaction, amount of reading performed, and health- and vision-related quality of life. Learners were also interviewed to obtain their subjective opinions.

Results. A total of 121 learners completed all stages of the study. There was no significant change in maximum reading speed. A statistically significant ($P < 0.001$) but small improvement in both critical print size and threshold print size was found, but frequency and duration of reading did not increase. There was a borderline significant ($P = 0.022$) increase in "life satisfaction" for the learners, but a highly significant ($P < 0.001$) decrease in their "positive affect." There was no change in health- or vision-related quality of life, or in the difficulty experienced in performing everyday tasks. However, according to learner interviews, 72% felt they had achieved a positive outcome from the training, and 75% felt they had received helpful advice in addition to the EV training.

Conclusions. The lack of improvement of reading speed and modest improvement in threshold print size should be interpreted in the context of the unique features of this EV program, since many learners who would seem to have limited scope for improvement still undertake the training.

Keywords: eccentric viewing, reading performance, training, visual impairment, macular degeneration

Individuals with bilateral macular disease (MD) experience blurred, distorted, or missing areas within their central visual field, which impairs their ability to carry out many activities of daily living, particularly those involving reading. If the affected retinal area includes the fovea, the person appears to compensate for this impairment by changing the gaze direction (eccentric viewing [EV]), so that the image of any object of interest is placed away from the damaged part of the eye, and onto an area of paracentral retina that has better potential for good vision—the preferred retinal locus (PRL).[1] However, because the resolving ability of the retina reduces as the distance from the fovea increases, the full potential for vision is usually realized only when the image is magnified (using either an optical or electronic aid). It appears that this repositioning of the image on the retina happens spontaneously and over a relatively short time period,[2] but it is not known whether EV can be enhanced by active training, or whether certain types of training would be more effective than others.[3]

Since its introduction in the 1970s in the United States[4] and Sweden,[5] EV training has been part of the rehabilitation offered in low-vision clinics worldwide. In contrast, such training is only sporadically available, and difficult to access, in the United Kingdom. The UK charity known as the Macular Society (Mac Soc) believes that everyone with central vision loss should be able to access holistic rehabilitation and low-vision services. Hence in 2006, Mac Soc instituted a program to develop and promote one particular model of EV training within the United Kingdom, particularly focusing on a technique known as steady eye strategy (SES) for reading. The program developed a network of volunteer EV trainers who have undergone a 3-day bespoke training course. Some trainers have macular conditions themselves; some are fully sighted; and some are professionals who work for partner third-sector organizations.

The trainers deliver free one-to-one training in EV and SES to people with MD in their local community (learners). The trainers aim to offer between one and three sessions, lasting no longer than 1 hour each; these are usually delivered in the learners' own homes or in a community venue. These sessions are generally held over a 2- to 3-month period in order to allow the learner time to practice the techniques in between the

Table 1. Data Gathered in the Study

	Data About Trainer Obtained by	Data About Learner Obtained by		
Data Obtained	**Researcher B**	**Trainer**	**Researcher A**	**Researcher B**
Demographic/baseline information	Before training		Before training	
Reading performance		Before and after training		
Life satisfaction rating[12]			Before and after training, 6 wk	
MLVQ			Before and after training, 6 wk	
PANAS			Before and after training, 6 wk	
EQ-5D-5L			Before and after training, 6 wk	
7-item NEI-VFQ			Before and after training, 6 wk	
VisQoL			Before and after training, 6 wk	
Satisfaction with/opinions about training				After training, 2 wk
Cost diary	After training, 2 wk			After training, 2 wk

Researchers A and B are two different members of the independent research team. MLVQ, Manchester Low Vision Questionnaire[7]; PANAS, Positive and Negative Affect Score[8]; EQ-5D-5L[9]; 7-item NEI-VFQ[10], 7 items selected from National Eye Institute Visual Function Questionnaire; VisQoL, AQoL-7D (Vision) Instrument[11].

sessions. Trainers also pass on handy hints and tips about using lighting, magnification, and contrast, but do not provide any form of low-vision assessment. They might suggest that learners seek a low-vision assessment or contact their local Social Services sensory impairment teams, and they might provide details of other support services.

The aim of the current study was to evaluate the effectiveness of the Mac Soc program provided in a community setting by volunteers, conducted by researchers who were independent of Mac Soc. The EValuation Study was not an evaluation of EV rehabilitation per se, since it is expected that other factors may influence clinical outcomes that cannot be controlled in the program (e.g., availability of optimum spectacles and magnifiers, application of vision-related eligibility criteria).

A previous evaluation of the program,[6] as well as anecdotal evidence from Mac Soc, suggested that the program delivered more than an improvement in reading skills, and so a wide range of measures were used to capture secondary outcomes that could have resulted from the intervention.

Methods

The EValuation Study received a favorable opinion from the University of Manchester Research Ethics Committee; informed consent was obtained from all participants, and the research followed the tenets of the Declaration of Helsinki. All existing trainers in the Mac Soc database, and all those trained during the period of the study, were encouraged to consent to be part of the EValuation Study. Individuals who joined Mac Soc were made aware of the availability of the training, and those members who wanted to learn the techniques registered their interest. As a trainer became available in their area, they were notified. If that trainer had agreed to be part of the EValuation Study, the learner was also sent a consent form to participate in the EValuation Study. If the learner did not consent, the trainer was notified to proceed with training, and there was no further involvement with the research team. If the learner consented, he or she received a pretraining phone interview (see Table 1 for content), which also confirmed eligibility (Table 2), and then the trainer was notified that the learner was ready to start training. The trainer was also interviewed to obtain baseline demographic data and confirm eligibility for the EValuation Study (Table 2).

Reading speed was chosen as the primary outcome, since this was typical in previous studies (reviewed in Refs. 13, 3). The aim was to obtain a complete dataset on 112 learners, based on a sample size calculation that included subgroup analyses for the effects of the use of magnification, the age of the participants, and the initial reading speed. These factors were all suggested to be related to the benefits accruing from the training in a previous evaluation of the program.[6] Although there had been no suggestion that age affected the reading performance improvements that were found, it was suggested that this might be the reason those improvements did not translate into improvements in reported quality of life in participants.[6]

Table 2. Eligibility Criteria for Learners and Trainers for the EValuation Study

Participants	Inclusion Criteria	Exclusion Criteria
Trainers	Training arranged and funded by Mac Soc on their specific 2- or 3-day courses	Trained by any other agency Not contactable by phone; no phone, hard of hearing
Learners	Having received information concerning the Mac Soc program, are interested in making an appointment to see a trainer, and are still interested when trainer becomes available	Not contactable by phone; no phone, hard of hearing Habitual language not English Simultaneously involved in training from another provider

To measure reading performance, a test was devised using single meaningful sentences of logarithmically decreasing size that had previously been used in published and prototype MNREAD tests by Gordon E. Legge (written communication, 2012) and were used with his permission for this study. The test resembled an abbreviated MNREAD Acuity Chart[14] with sentences from 64 point to 4 point in size, arranged across two A4 sheets. It was designed to be printed on paper to be posted to trainers and to be placed on an A4 clipboard (which is the preferred method of holding reading material in the training program). Using this test it was possible to determine maximum reading speed, critical print size (the smallest print read at the fastest speed), and threshold print size. Four different versions of the test were used in an ad hoc sequence. A different version of the test was used for each learner's pre- and posttraining assessments.

Learners were asked to use their preferred spectacles and/or magnifiers, just as they would if trying to read small print, and to read the text as quickly and accurately as possible. Trainers measured the reading distance from the learner's cheek to the clipboard using a long strip of paper, which they tore off at the appropriate distance: They were asked to do this at the beginning and check it again at the end of the test (the latter is the value reported here). The only other instruction to the trainers was to encourage learners to try smaller print if they found the large size too big (as could be the case if they were using a high-powered magnifier). Trainers were provided with digital recorders to audio record the reading test performance, and they also reported on the aids being used by the learner (spectacles, magnifiers, lighting): It was therefore possible to determine whether pre- and posttraining reading took place under the same conditions. Recordings were later analyzed using audio editing software (Wavepad Sound Editor v5.00, NCH Software, www.nch.com.au/wavepad; in the public domain) to identify reading errors and the time taken to speak each sentence. If the learner was to have only one visit (i.e., he or she did not want to proceed with training or was considered unsuitable for training), then the trainer repeated the reading test (using a different version) at the end of the visit. Otherwise the training proceeded, and reading was voice recorded again at the final visit, several weeks later.

All the remaining data were gathered by pre- and posttraining telephone interviews. The same sequence of questionnaires was used in all cases (as shown in Table 1). The interviews to repeat the questionnaires were scheduled to take place 6 weeks after the end of the training. A single-item "life satisfaction" rating was also used[12] and formed the first item of each interview. An adaptation of the Manchester Low Vision Questionnaire (MLVQ)[7] was used to identify what spectacles/magnifiers were used to read small print, how often the person had read within the last 4 weeks (graded 4 [>5 times per day] to 0 [never in the last 4 weeks]), and the average and longest times spent reading on each occasion (graded 4 [$\geq$30 minutes per day] to 0 [<1 minute per day]). Learners' knowledge of visual impairment was assessed by asking whether they agreed or disagreed with the following statements about vision: "Using your eyes too much will make your remaining vision worse"; "Sitting too close to the TV causes your eyesight to worsen"; and "When you are reading, more light will improve your ability to see."

The PANAS scales of positive and negative affect[8] were used to assess mood. This section of the interview consists of 20 words that describe different feelings and emotions. The learner is asked to respond to "to what extent have you felt this way over the last 2 weeks." The words are "interested," "distressed," "excited," "upset," "strong," "guilty," "scared," "hostile," "enthusiastic," "proud," "irritable," "alert," "ashamed," "inspired," "nervous," "determined," "attentive," "jittery," "active," and "afraid." The options are very slightly or not at all (1), a little (2), moderately (3), quite a bit (4), and extremely (5). Ten of the words represent positive emotions and 10 are negative: The scores for each category are summed to give total affect scores, which could range between a minimum of 10 and a maximum of 50. These scales have shown significant changes in elderly participants as a result of a nonmedical intervention.[15]

The functional outcomes in terms of activities of daily living were captured using the seven-item NEI-VFQ,[10] which asks responders to grade their difficulty (from 1 [no difficulty] to 5 [stopped doing because of eyesight]) with reading newspapers, doing close work or hobbies, reading street signs, going out to the theater or sports events, reading small print, figuring out bills, and watching TV. This was used in a previous study of community-based vision rehabilitation, is "short, reliable and psychometrically robust" (p. 179),[16] and has been found to be responsive to rehabilitation intervention. The original NEI-VFQ wording of the questions was used.

To assess the cost-effectiveness of treatments, the EQ-5D[9] measures generic health-related quality of life (QoL) and is the instrument recommended for comparisons of different health states by the National Institute of Health and Care Excellence (NICE) in the United Kingdom.[17] The EQ-5D-5L requires learners to rate the extent of their problems in five areas: mobility, self-care, performance of usual activities, pain/discomfort, and anxiety/depression. However, even in the five-level version, there are doubts about whether EQ-5D is able to accurately represent the visual state, or be sensitive to visual change.[18] In addition to EQ-5D-5L, therefore, the AQoL-7D (Vision) (VisQoL) was used,[11] since this was specifically designed to measure vision-related QoL. VisQoL consists of six questions that ask learners about the effect of vision on risk of injury, ability to cope, friendships, ability to arrange assistance, ability to fulfill desired roles, and confidence to join in everyday activities.

The intention was to carry out a cost–benefit analysis, so approximately 2 weeks after the end of training, a "cost diary" interview was undertaken with both trainers and learners. These were used to identify both monetary and time costs involved in participation in the study: the time involvement for trainers and learners when meeting; the time devoted to any homework and practice; information about the facility in which the training took place; transportation to this location; equipment involved in the training (e.g., reading materials); and additional equipment (e.g., lamps, clipboards) obtained by learners to help with reading. In that same interview, learners were also asked open-ended questions concerning their opinions of, and satisfaction with, the training process. These interviews were analyzed by two researchers independently to identify positive and negative themes and the frequency with which those themes appeared.

Results

The EValuation Study recruited participants during the period of October 2012 to November 2013. Recruitment ceased when it was felt that the completion target would be reached (using estimates of dropout rate); but in fact this was exceeded, and 121 learners completed all sections of the study, although some data were unusable/missing. The flowchart (Fig. 1) shows the progress of learners through the study. Of the 121 learners who completed the study, 9 had only a single visit with the trainer, so they are assumed to be untrained. All other participants who had more than one visit are assumed to have

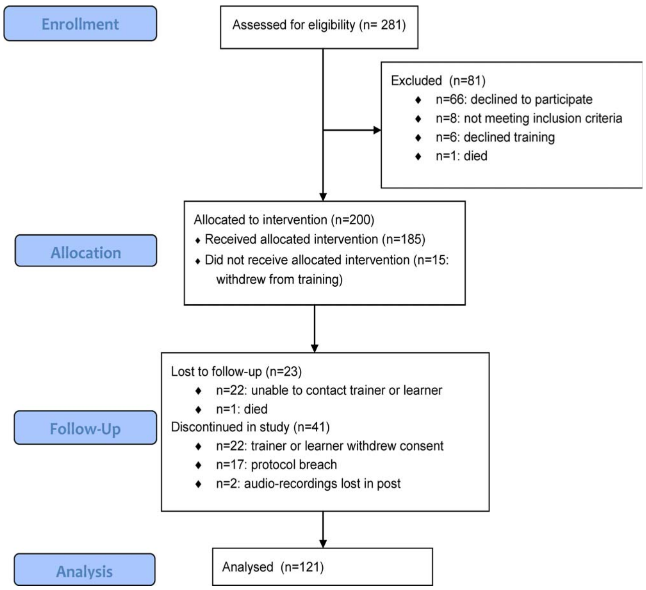

Figure 1. A flowchart showing the number of learner participants at each stage of the study.

undergone training (112/121 = 92.5%). Unless stated otherwise, all learners are included in the analyses.

During this period there were approximately 215 trainers who were active and accepting referrals from Mac Soc, and 88 consented to join the EValuation Study. Overall, 281 learners were matched to 58 of the consenting trainers and issued consent forms; 200 started the study, with 121 completing, trained by 34 of the trainers. The timing of the posttraining interviews was often difficult to control, since the research team knew that training had been completed only when the reading test recording was received from the trainer. The median time from receiving the posttraining (second) reading test to the cost diary interview was 51 days, and the median time to the questionnaire interview was 91 days.

The background information obtained in the baseline interview with learners before they started training is summarized in Table 3.

Based on the reports of the trainers, only 54 participants used magnification during the reading tests (50 optical [41.3%] and 4 electronic [3.3%]). A total of 51 (42.2%) were reported to be using no aid, or spectacles only; and for 16 (13.2%), status was not reported. Of those using an optical magnifier, the distance between the learner's cheek and the test material at the end of the reading test was 26.26 ± 11.44 cm (range, 4–47 cm).

The usual instruction given when conducting a reading test is that the reader should not correct mistakes and should carry on to the end; incorrect or missed words are then accounted for in the scoring. To keep the test simple for the trainers, they were not asked to give this instruction. Hence, because the test consists of meaningful sentences, learners almost always went back and corrected their mistakes, and in some cases would probably not have been able to continue at all without the contextual clues. This scenario inevitably increased the variability and duration of the reading speed measurements, with an occasional very slow sentence while the reader sorted out his or her mistake and reread the sentence through, sometimes several times.

The threshold print size (TPS) was taken as the smallest that could be read by the learner with no more than 2 of the 10 words in that sentence read incorrectly. It was found that one or two word errors tended to be minor (e.g., "coat" rather than "coats," or "the hat" rather than "his hat"), so the meaning conveyed was largely unaffected. Reading speed (in words per minute, wpm) was calculated for each sentence, from the reading time in seconds (measured to the nearest millisecond), using the formula

$$\text{Reading speed} = (10 - [\text{words missed}]) \times 60/\text{time taken}.$$

The maximum reading speed (MRS) was the highest achieved for any sentence in the test. The critical print size (CPS) was the smallest size that could be read at the fastest speed: In the current study, this size was interpreted as the smallest print read at 80% of the MRS. The reading data are summarized in Table 4.

There was no change in mean MRS as a result of training, although there was a highly statistically significant decrease (improvement) in the print size that could be accessed. All of these parameters are extremely variable between individuals, which can be seen in Bland-Altman[19] analyses of MRS (Fig. 2) and TPS (Fig. 3). Multivariate ANOVA was performed to identify whether any factors were related to the measured changes;

Table 3. Demographic Data for the Participants Who Completed the Study ($n = 120$; Data for One Participant Are Missing)

Learner Characteristics	Number (%)
Age	
<60 y	3 (2.5)
60–70 y	14 (11.6)
70–80 y	27 (22.5)
80–90 y	65 (54.2)
>90 y	11 (9.2)
Sex	
Male	39 (32.5)
Female	81 (67.5)
Live alone	
Yes	61 (50.8)
No	59 (49.2)
Time since last sight test for spectacles	
<1 y	98 (81.6)
1–2 y	8 (6.6)
2–5 y	2 (1.6)
>5 y	1 (0.8)
Don't know	11 (9.2)
Do you have spectacles to use for reading?	
No	13 (10.8)
Yes, but don't use	11 (9.2)
Yes	96 (80.0)
If yes, how long have you had your spectacles?	
<1 y	32 (29.9)
1–2 y	24 (22.4)
2–5 y	13 (12.1)
>5 y	11 (10.3)
Don't know/many years	27 (25.2)
Do you have a magnifier for reading?	
No	8 (6.7)
Yes, but don't use	4 (3.3)
Yes	108 (90.0)
If yes, how long have you had your magnifier?	
<1 y	35 (31.3)
1–2 y	28 (25.0)
2–5 y	19 (17.0)
>5 y	14 (12.5)
Don't know	16 (14.3)

TABLE 4. Mean (±SD) of Reading Performance Parameters Derived From Audio Recording of Reading of Meaningful Sentences ($n = 106$) (NS, Not Significant)

Reading Parameters	Before Training	After Training	Change	Significance
MRS, wpm	104.33 ± 59.29	104.34 ± 58.18	+0.01 ± 27.39	NS
CPS, point size	34.86 ± 22.43	29.69 ± 21.69	−5.20 ± 18.44	0.005
TPS, point size	19.99 ± 21.22	15.57 ± 17.59	−4.42 ± 10.92	<0.001

neither age, initial reading rate, nor magnifier use was significantly associated with change in performance. Nine of the participants were untrained (they had only one visit, and both their reading tests were conducted at the same visit). When they were excluded, this did not materially change the results. If participants were divided into three groups by initial reading speed (<40 wpm [18.9%]; 40–80 wpm [18.7%], and >80 wpm [63.2%]), there was a tendency for greater change in MRS in the poorest readers (mean log change in MRS = 0.23 ± 1.04), but this did not reach statistical significance. Figure 2 also illustrates that the change in MRS does not appear to be related to the pretraining reading speed. If participants were grouped by age (<80 years and ≥80 years), there was a tendency for the older group to get slightly better reading speed and access to slightly smaller print post training, but this did not reach statistical significance.

Although the changes in CPS and TPS are statistically significant, they are modest and show considerable interindividual variability, which is illustrated in Figure 3 for TPS. The clinical (i.e., functional) significance of these changes is unknown, but may be greater than practitioners would expect. If large print was 16 point, then before training, 35.2% of participants could "comfortably" access this (i.e., their CPS was ≤16), and after training this had risen to 44.8%. The equivalent shift for accessing standard print (10 point) was from 20% to 23.8%.

Although 121 learners completed the before and after questionnaires, there are some missing data (since learners could decline to answer any question on either occasion). There are therefore different numbers of learners in each dataset.

The life satisfaction ratings (LSR) are based on 114 learners. Life satisfaction rating changed from a mean value of 6.51 ± 2.36 before training to a mean of 6.99 ± 2.27 at the posttraining interview. A paired t-test suggested that this improvement was statistically significant ($P = 0.022$), although this must be interpreted with caution in this study considering the number of significance tests being conducted. However, the change in LSR is highly significantly correlated to the change in MRS ($P < 0.001$), although the strength of the correlation is moderate ($r = 0.28$). With regard to calculating the positive and negative affect scores, a number of participants were unable to answer one or more of the questions ("attentive" and "proud" were particularly difficult for some learners to interpret), so the average score for the responses given was multiplied by 10 to give the final score.

It can be seen (Table 5) that this study population has a positive affect similar to that of the general population sampled by Crawford and Henry.[20] The slightly lower positive affect score is understandable, since this is known to be associated with female sex and older age. The negative affect score in the learners is considerably higher than might be expected: They had a higher (worse) score than 80% of a general population sample.

After the training, there was a fall (worsening) in positive affect that was highly statistically significant. The fall (improvement) in negative affect was not statistically significant. However, neither of these changes correlated with changes in MRS, CPS, or TPS.

The responses to the MLVQ are summarized in Table 6.

The results showed no significant change in frequency or duration of reading. The learners were questioned about their knowledge of visual impairment. The knowledge score ranges from 0 (if giving none of the intended answers) to 3 (for giving all correct). It might be expected to rise as a result of the training, since the trainers were imparting general information about visual impairment to their learners. However the mean knowledge scores were 2.18 ± 0.83 before training and 2.19 ± 0.84 after training.

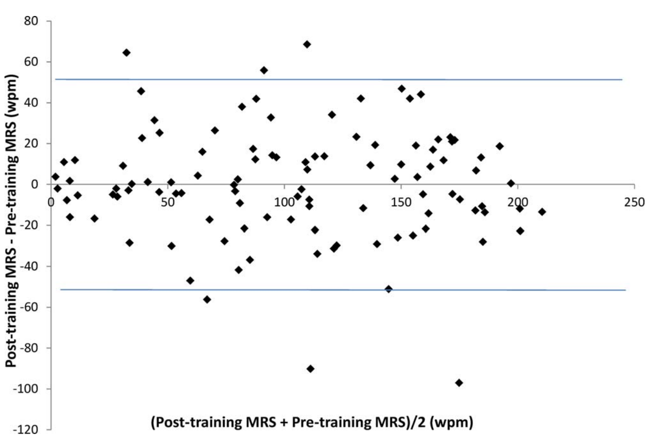

FIGURE 2. A Bland-Altman plot of the difference between post- and pretraining maximum reading speed (MRS) in words per minute (wpm) (y-axis), versus the mean of the post- and pretraining MRS (in wpm) (x-axis). The *blue lines* represent the 95% confidence limits of the difference. A positive mean difference indicates an improvement in performance post training. The mean difference was –0.06 and so overlaps with the x-axis.

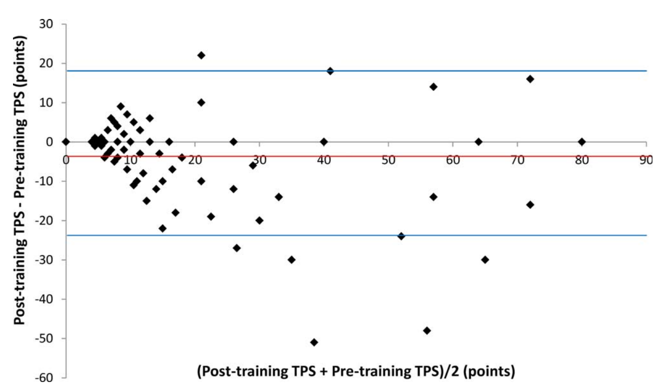

FIGURE 3. A Bland-Altman plot of the difference between post- and pretraining threshold print size (TPS) in point size (y-axis), versus the mean of the post- and pretraining TPS (in point size) (x-axis). The *blue lines* represent the 95% confidence limits of the difference, and the *red line* indicates the mean difference. A negative mean difference indicates an improvement in performance post training.

Table 5. Pre- and Posttraining Scores on the PANAS Questionnaire (n = 121, NS, Not Significant)

Scores	Positive Affect	Negative Affect
Population norms,[20] median	32	14
Before training, mean ± SD	31.73 ± 7.18	19.05 ± 7.50
After training, mean ± SD	30.36 ± 7.67	18.62 ± 6.48
Change, after-before, mean ± SD	−1.47 ± 4.34	−0.45 ± 6.42
t-test, 2-tailed, paired sample	$P < 0.001$	NS

Although the numbers answering "correctly" were very similar before and after training, the detail of the responses (Table 7) shows that there were quite a number of individuals who changed their answers (shown in the final columns).

It was clear from the way in which learners answered the questions that a number of them answered yes to the first question because they equated making vision worse with the tiredness that they felt when carrying out visual tasks. Therefore, carrying out the EV training might have made more learners answer yes because the training made their eyes tired, or no because using EV and SES was less tiring than their usual reading strategy. As can be seen from the table, there was no systematic change here: Both changes were equally likely.

For the seven-item NEI-VFQ, the published algorithm derived from Rasch analysis[10] was used to derive person scores for each learner before and after the training. One question created some difficulty for some responders, since it asked how much difficulty the responder had with tasks "such as cooking and sewing." Two learners responded 1 for cooking and 5 for sewing: This response was treated as missing data. The range of possible person scores was –3.22 logits (no difficulty with any tasks) to +3.39 logits (stopped doing all tasks). The mean person score before training was 0.22 (±1.64) logits, and after it was 0.14 (±1.63) logits. The mean before and after difference in the scores for the learners was –0.06 (±1.13) logits, which is a very small proportion of the possible range of scores, so it was neither statistically ($P >$ 0.05) nor clinically significant. The profile of answers for the EQ-5D-5L was analyzed to give an index for each learner with reference to the UK dataset. In this set the range of scores is +1.00 (good health-related QoL) to –0.594 (poor health-related QoL). In the learner cohort the mean (±1 SD) index before training was 0.65 ± 0.22, and after training it was 0.63 ± 0.23. The mean pre- to posttraining difference for all the learners was 0.00 ± 0.22. The profile of responses to the VisQoL was used to provide a dimension score. The scores range from 0 (severe effect of vision on QoL) to 1.00 (no effect); a higher score is better. The mean dimension score before training was 0.61 (±0.22) and after training it was 0.61 (±0.21). The mean of the differences for all the learners was 0.00 (±0.16).

None of these QoL instruments showed a statistically significant change as a result of training. These mean values disguise the fact that some learners did experience dramatic changes in scores, in both directions. Investigating a possible link for each with changes in reading performance showed that the correlation between an improvement in VisQoL score and an improvement in MRS was 0.23 ($P = 0.018$), which suggests a modest link between the two.

Cost diary interviews were conducted with both the learners and the trainers, but only the time spent by learners is reported here. Learners confirmed that, as planned, the median number of sessions was 3 (mean 2.95). The length of sessions varied between 10 and 120 minutes, with a median of 60 minutes (mean session 1: 58.4; session 2: 55.2; session 3: 56.9). The median total training time was 180 minutes (mean 170).

It was assumed that all learners who had more than one training session were encouraged to practice in the intervening time. The length of practice per day reported by learners was highly variable, from 0 to 240 minutes: Very long durations involved learners who read for a high proportion of the day (e.g., at work), using the new techniques on all occasions. The median reported practice time per day was 15 minutes. A total of 51 learners said they practiced on 6 or 7 days per week; 37 on 3 to 5 days per week; and 11 on 1 or 2 days. Twenty-two said they did not practice at all, although 9 of these were learners who only had one session. Therefore the calculated practice time per week (adding all the days together) varied from 0 to 540 minutes with a median of 65 minutes. To calculate the overall practice time throughout the training, the

Table 6. Responses of the Learners to the MLVQ Part 2 Before and After Training

Questions	Before Training	After Training
"If you were going to try to read small print . . . would you use a magnifier? Can you describe it to me?"		
Illuminated unknown type	11	12
Illuminated hand	47	43
Illuminated stand	3	12
Nonilluminated unknown type	7	3
Nonilluminated hand	19	16
Electronic, handheld	3	3
Electronic, desktop	12	15
Spectacle mounted	4	2
No magnifier	15	15
"How often have you read any sort of print in the last 4 weeks?" 4 = many times (>5) each day; 3 = several times (1–4) each day; 2 = weekly (<1 daily but at least ≥1 per week); 1 = occasionally (<1 per week); 0 = never (not at all in last 4 weeks); IF SCORE 0, automatically score 0 on next 2 questions.	2.95 ± 1.17	2.99 ± 1.00
"If you think about all the times you have read anything in the last 4 weeks, what is the average length of time you have read for on each occasion?"	2.21 ± 1.24	2.27 ± 1.19
"What is the longest time you have read (on any 1 occasion) in the last 4 weeks?" 4 = ≥30 minutes; 3 = >15 minutes and <30 minutes; 2 = >5 minutes and <15 minutes; 1 = ≥1 minute and <5 minutes; 0 = <1 minute	2.57 ± 1.34	2.70 ± 1.27

Table 7. Number of Learners Agreeing or Disagreeing With Each of the Statements Regarding Vision (Only the Learners Giving the "Correct" Answers Are Shown)

Statements From MLVQ	Intended Answer	Before Training Yes	Before Training No	After Training Yes	After Training No	After Training Change to Yes	After Training Change to No
"Using your eyes too much will make your remaining vision worse."	No		74		71	19	17
"Sitting too close to the TV causes your eyesight to worsen."	No		86		88	13	16
"When you are reading, more light will improve your ability to see."	Yes	104		104		11	11

lengths of the intervals between the training sessions were added together. The median value was 3.17 weeks between the first and second session and 2.93 weeks between the second and third session. Calculating the total practice time for each learner gave a median of 360 minutes, or 6 hours. There was no correlation of practice time with the changes in MRS, CPS, or TPS.

As a way of finding out about learner satisfaction with the study, the learners were asked what they had wanted to achieve from the training and whether they had achieved that outcome (Table 8).

Of the 117 learners, 84 (42 + 32 + 4 + 6) (72%) achieved, at least partially, a positive outcome. Of those 11 learners who went into the process with no expectations or were skeptical about the training, over half experienced a positive effect. Some of those who achieved their primary goal (e.g., reading) also reported additional benefits: The most common was an improvement with regard to watching TV.

Table 9 shows the change in MRS and TPS for the learners who felt that they had or had not achieved their aim of reading better. The changes for the group that achieved their aim suggest that any link between the subjective perception and the objective reading performance is perhaps more likely to be due to TPS than to MRS. Although the improvements in TPS are small and do not reach statistical significance, the "successful" group achieved a posttraining TPS that was more likely to be useful in accomplishing everyday tasks requiring access to print.

The learners were not asked specifically about the trainers; it had been important in recruiting trainers to the study that we could assure them that they were not being personally assessed in any way. However, when asked about good and bad features of the training, the trainer was mentioned by 63% of learners. The trainers were perceived to be well trained, knowledgeable, friendly, and patient. A total of 75% of learners reported receiving helpful advice in addition to that relating to the EV training: This included 44% about lighting, 43% about visual aids, and 9.5% about technology and gadgets (some learners reported receiving good advice in several categories).

Table 8. Expectations of the Learners Before Their Training and the Number Who Achieved Their Goals ($n = 117$; Missing Data for 4 Learners)

Satisfaction Interviews	*N*
Expectations	
To read better	64
Other visual improvement, or to use eyes better	29
Information about the technique	11
Other aims	2
No expectation/skeptical	11
Outcomes	
Learners with expectations, $N = 106$	
Achieved fully	42
Achieved partially	32
Achieved another goal instead	4
Did not achieve anything	28
Learners without expectations, $N = 11$	
Achieved a positive outcome	6
Did not achieve anything	5

Discussion

The organization of the program was in general very well received by the learners. The learners had a high average age and welcomed the fact that the training could be conducted in their own home. A significant majority (72%) believed that they had achieved a positive outcome and that they had received helpful advice. It might have been expected from this that the learners would have had better knowledge about visual impairment following the training. However, the scores of the learners for the MLVQ knowledge questions were not improved post training.

Despite the subjective reports from learners, there was no improvement in reading speed and only a modest improvement in TPS. It could be argued that the reading test used was not appropriate, but the single-sentence format is well established in low vision and is likely to have been easier for the learners than a test of extended reading. This test also allowed the performance of individuals with a wide range of acuities to be tested using the same reading material. The sentence reading test is more representative of survival rather than leisure reading, which is a more realistic goal for persons with a central scotoma. The criteria for MRS (i.e., the single highest reading) has been used in other studies,[21] but is more generous than the averaging methods used by most investigators.[22] However, in the current study, the largest print was often the one that was read at the fastest speed (31 learners before training, 24 after training), and it is known that speed for the largest size text is often less than optimal because of the angular extent of the text.[23] It was not possible to use averaging in this study since there were often insufficient values, and there was a possibility that the average would have combined some readings with a magnifier and some without. This lack of averaging may have contributed to increased variability in the measurements, making it more difficult to establish statistical significance; but there is no suggestion in the mean results of any trend toward improvement in reading speed with training. Ahn and Legge[24] suggest that the reading speed with large print is highly predictive of the reading speed achieved with a magnifier, so this measure of reading performance would be expected to improve even if the learner did not have appropriate magnification. In 13% of cases, the trainer did not report the conditions under which the pre-and posttraining reading tests were carried out (i.e., with or without a magnifier), and it is possible these were

TABLE 9. Mean (±SD) of Reading Performance Parameters for Three Groups of Readers, Divided by Their Satisfaction With Training

Statisfaction With Training	Pretraining MRS, wpm	Posttraining MRS, wpm	*t*-Test Significance	Pretraining TPS, Point Size	Posttraining TPS, Point Size	*t*-Test Significance
Aim to read better not achieved, $n = 22$*	97.3 ± 57.1	79.3 ± 65.2	$P = 0.21$	23.8 ± 22.2	17.9 ± 17.2	$P = 0.13$
Aim to read better achieved, $n = 42$	110.2 ± 46.1	106.0 ± 54.1	$P = 0.42$	14.9 ± 15.5	12.6 ± 15.5	$P = 0.06$
No expectations regarding reading, $n = 57$	106.7 ± 69.0	97.4 ± 65.3	$P = 0.17$	22.3 ± 24.0	16.8 ± 19.1	$P < 0.001$

Group 1: Training aim was to read better, and learner felt aim was not achieved; Group 2: Training aim was to improve reading, and learner felt this was achieved; Group 3: Learner had no expectations regarding reading prior to training.

* Missing reading data for one participant.

different, thereby diluting a training effect. However, for the other 87% of learners, it is known that the same aids were used for both tests.

In order to obtain optimum visual acuity using EV, it is important that the image be focused on the retina, and, in most cases, that magnification also be available. In the earlier report on the Mac Soc training program,[6] it appeared that only about one-third of participants were using magnifiers. Although this limitation had therefore been a major concern for the current study, it seemed unfounded based on the number of learners who possessed up-to-date spectacles, and magnifiers. The question "How long have you had your spectacles?" probably overestimates the age of the current spectacles in some cases, since some responders misinterpreted the question as "How long have you been wearing reading spectacles?" It is one thing to possess a magnifier but another to use it, and learners were asked a separate question about what spectacles and/or magnifiers they would use if they were going to try to read small print. Although 88% said they would use a magnifier, only 45% are confirmed to have done so during the reading test. Therefore, although there was every reason to expect that most learners were in a position to take full advantage of any improvement in their fixation abilities brought about by the training, it seems that some learners chose not to do this. Even those who did use an optical magnifier used relatively long working distances; especially when using SES, the optimum position for the magnifier is to place it close to one eye, consistently viewing through the center of the lens to avoid aberrations and image movement (from lens prismatic effect). Better results may have been achieved if the trainers had emphasized the importance of correct magnifier and spectacle usage, although this would require a change in their own training.

Whereas a clinical trial may have strict inclusion criteria, the Mac Soc program is open to any individual who joins the society. As a volunteer-delivered service provided in a community setting with a national footprint, it is not possible to prescreen to establish visual function before individuals meet with their volunteer trainer. This restriction potentially means that individuals with vision either too good or too poor to benefit from the techniques, or indeed with other comorbidities (e.g., dementia, severe physical tremors or head movements) that limit the ability to fully participate in the learning activities, might be included. There is also a group of individuals diagnosed with macular degeneration, perhaps with vision loss in one eye, who wish to find out more about the technique as a backup in case of vision loss as the disease progresses. This group (9/121 [7.5%]) in the current cohort) would be expected to have only one session with the trainer. All other participants who had more than one visit were assumed to have undergone training (112/121 = 92.5%), suggesting that this is the proportion of unselected learners who were suitable for training. This figure is likely to be an overestimate even in this program: Many of the protocol breaches (Fig. 1) were individuals who were (incorrectly) withdrawn from the study by trainers because they were unsuitable. More significantly, it also appears that there were a large number of learners with already good reading performance who trainers were willing to train: Before training, over 50% of learners had MRS in excess of 100 wpm, and around 20% read at more than 160 wpm. In a large mixed group of patients with AMD provided with optical or electronic magnifiers, the mean reading speed was 72 wpm.[25] Reading is usually even slower in those undertaking EV training: Pretraining reading speeds reported range from 12 ± 5 to 58 ± 33 wpm.[13] In the current study, however, the mean reading speed did not change significantly, even for the group with a pretraining reading speed less than 40 wpm.

There is no suggestion in previous work that the training should be made available to anyone who would like to undertake it. It has been possible for other services to screen out unsuitable learners because training is not offered as a standalone provision, but in partnership with a service that first offers optimal refractive correction and magnification, both of which are seen as fundamental. Similar training methods applied in Sweden[26] were initially offered to only 60/351 patients with AMD who attended for visual rehabilitation (the majority just needed simple magnifiers). In addition to those who need only simple magnification, there is also a group whose physical and mental well-being is poor, and they are most unlikely to be in a position to benefit; Nilsson and Nilsson[26] and Palmer et al.[27] both excluded individuals in this category.

The mean critical and threshold print sizes accessible by the group did show a statistically significant improvement, but only by a relatively small amount. This improvement still left the mean performance at the level of reading large print rather than standard print. Perhaps surprisingly, improvements in print thresholds were not related to magnifier use, maybe because of this relatively low level of performance. If the mean print threshold achieved had been 6-point print, for example, it would seem extremely unlikely that this would not be strongly influenced by use of a magnifier. Across the whole group, the number of times the learners read and the duration of their reading also did not change. The Macular Society claims additional advantages of learning EV ("Learning new ways of seeing can help with reading, taking care of yourself, getting about and watching TV"[28]), but the seven-item NEI-VFQ showed no changes in learner difficulty in carrying out a range of distance and near tasks.

The Macular Society makes it clear, and this seems well understood by learners, that EV training does not work for everyone. However, if this training does not work because it is being delivered at the wrong time (e.g., when vision is too good), this may be detrimental to the learner. If learners' vision deteriorates such that they might then benefit, they may think it is not worth trying the training again, believing that they will never be suitable for it. It may therefore be inappropriate to continue to offer the training simply to anyone who would like to undertake it.

A key part of the training process is practicing the EV and SES techniques regularly between sessions with the trainer. The majority of learners reported practicing, and the median time spent seemed appropriate at 15 minutes per day and just over 1 hour per week. Time spent was, however, extremely variable, which suggests that this was not perhaps as structured a regimen as it seems to be in other programs (e.g., keeping diaries[27]). The time between sessions with the trainer was relatively long compared to other programs, at 3 weeks, and this is in fact slightly less than the expectation of a 1-month interval suggested by Mac Soc. It could be suggested that this long interval might reduce the intensity of, or motivation for, practice, but this was not apparent from the interview responses. It also does not give the trainer any opportunity to correct an inappropriate technique or offer progression. Interestingly, the amount of practice time reported did not correlate with any changes in measures of reading performance.

The possible links between "mood" and training are somewhat equivocal. Overall life satisfaction showed a mean increase, which was of borderline statistical significance, yet there was a very strong correlation to change in reading speed. This finding suggests that if training is successful in improving reading speed, this improvement does a have positive effect on this QoL measure. However, an alternative measure to judge mood, the positive affect, showed a highly significant decrease from before to after training. The change in positive affect did not, however, correlate with any reading performance changes. This would suggest that this change is an effect of the general aging of the group and their other life changes and is unrelated to the training itself.

The mean changes in health-related QoL were negligible, but this mean figure does disguise the fact that there were some marked gains and losses for individual learners. However, these changes were not strongly correlated with any measures of reading performance, so it is difficult to identify their cause. The current study supports those who suggest that EQ-5D and VisQoL are measuring different aspects of QoL, since there was only moderate correlation between them. Unfortunately, it is not possible to say which of these, if either, is more appropriate for measuring the effects of visual rehabilitation, since neither was changed by training in this study. There was, however, a modest correlation between change in the VisQoL score and change in MRS, suggesting that the VisQoL measure may be more sensitive.

As first and foremost a pragmatic "real-world" evaluation of service effectiveness, there are a number of limitations to the design of this study that were unavoidable. The before and after type of study is, at best, considered to provide low-quality evidence for the effectiveness of an intervention. In the current study it was not possible to include a control group because Mac Soc did not wish to incorporate a waiting list arm in the study. Although the lack of convincing quantifiable change from the intervention is disappointing, it may be that a control group would have shown a significant decrease in performance. The most likely explanation, however, is that some learners improved and others got worse, with minimal change overall in the mean group performance: This can be seen in the Bland-Altman analyses in Figures 2 and 3.

The timing of the posttraining interviews proved to be much longer following the training than had been planned. This delay was partly due to the research team's being aware that training was complete only when the audio recordings were received from the trainer. These were often not received immediately because the trainer kept the recorder for visits to other learners. Further delays were due to difficulty in reaching the learners by phone. It could be argued that the effect of the training as gathered in the secondary outcomes was therefore diluted by vision worsening in the learners as time elapsed. However, if the condition was stable, the effect of training may have been enhanced by the longer time period as the learner had more time to develop the skill he or she had learned. This delay did not affect the reading performance measurements.

In summary, the Mac Soc training program for EV is well organized and well resourced, and uses recognized training methods. Despite this, it did not achieve any significant improvement in reading speed, and only a modest improvement in TPS for the group of learners overall. This illustrates the importance of rigorous evaluation of rehabilitation interventions, which can provide suggestions for changes to service provision. In this case, it would seem important to alter the recruitment of learners to target those who might be most likely to benefit from this costly and intensive training.

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