

Eye-Fitness: A Home-Based Rehabilitation Program for People with Central Vision Loss

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Abstract

Purpose: Low vision rehabilitation involves important challenges due to age-associated physical and psychological issues and transportation barriers. Home and telerehabilitation training could overcome these problems. The aim of this prospective study was to evaluate the efficacy of a customizable computer-based tele-rehabilitation program (CBRP). Patients' usability was also evaluated.

Methods: Nine patients with central vision loss due to Macular Degenerations were included in the study. A standardized protocol of examination was performed in all participants, before and after the home rehabilitation training, by measuring: best corrected visual acuity (BCVA), contrast sensitivity (CS), reading acuity (RA), fixation stability (BCEA) and reading speed (RS). The CBRP was performed using Eye-Fitness (Nidek Technologies, Padua, Italy), including 19 customizable exercises. 14 visual home-training sessions were performed daily binocularly.

Results: The mean CS resulted to be significantly improved from $0.5 (\pm 0.2)$ to $1.08 (\pm 0.3)$ LogC ($t(8) = 6.1, P = .001$) in the better eye and from $0.4 (\pm 0.5)$ LogC to 0.7 ± 0.4 LogC ($t(7) = 2.9, P = .01$) in the worse eye respectively. Mean binocular reading performance increased from $50.6 (\pm 26.9)$ to $67.6 (\pm 22.7)$ wpm ($t(8) = 13.2, P = .001$). BCEA 68.2% values were significantly smaller for both the better eye (from $8.87^{\circ}2 (\pm 10.6)$ to $1 (\pm 1.79)$ ($t(8) = 3.4, P = .004$) and for the worse eye (from $10.6^{\circ}2 (\pm 1.9)$ to $2.26 (\pm 0.69)$ ($t(7) = 4.5, P = .002$). Mean accuracy and reaction time were significantly better after training (from $52.3 (\pm 29.7)$ % to $84.9 (\pm 19.60)$ %; $F = 45.30, P < .01$ and from $35.7 (\pm 27.7)$ sec to $9.3 (\pm 1.7)$ sec ($F = 80.5, P < .05$) respectively.

Conclusions: The findings of this study provide evidence of the effectiveness of the home rehabilitation intervention for visually impaired subjects by showing an improvement of visual functions. This new technique may contribute to avoid the issues related to attending a visual rehabilitation program.

Keywords: Macular Degenerations; Tele-Rehabilitation; Home-Training; Low Vision

Introduction

Low vision rehabilitation is considered the principal intervention for people with chronic and uncorrectable visual impairment such as Macular Degeneration (MD) in order to overcome visual disability and restore independency loss due to the disease. MD involves elder and juvenile people with severe impact on daily living activities requiring vision such as reading and writing [1]. The onset of a central scotoma, due to maculopathy, decreases central vision, contrast sensitivity and visual acuity allowing the development of a new fixation point, the preferred retinal locus, PRL, localized in the healthy area at the edge of the scotoma [2-4]. The recent experience of the Low Vision Intervention Trial (LOVIT) group showed a positive effect of inpatient low vision rehabilitation on self-reported visual function [5]. Low vision rehabilitation programs include different kind of devices, such as magnifiers, useful for reading the smallest character size,

and training compensatory strategies that can improve reading ability. Different studies reported the usefulness of rehabilitation in improving reading ability with low vision aids [6]. Moreover, central scotoma patients with eccentric vision could benefit from the use of the microperimeter biofeedback training for improving fixation stability of the PRL, visual acuity and reading speed. The training is controlled by an operator and guided by a sound for maintaining the fixation point, but it is a static program, not assessed during everyday life dynamic conditions that involve eye movement such as reading [7-12]. Although patients showed improvements of visual performance and benefits from rehabilitation intervention, they refer also problems for support and transportation depending on these needs by others; 2/3 low vision people do not drive [13]. This could result in an high rates of abandonment and the rehabilitative purpose could be disregarded [14]. Tele-rehabilitation could overcome these disadvantages with the possibility to deliver rehabilitation services via information and communication technologies [15]. The current low vision rehabilitation approach presents important challenges due to elderly age, age-associated physical and psychological issues, co-morbidities and transportation barriers. Tele-rehabilitation, by means of delivering rehabilitation services via web, may offer several advantages such as an improvement of vision and health-related outcomes [16]. Therefore, it is important to help patients with vision loss in order to maintain their functioning and enhance activities of daily living, as well as their social and psychological well-being. To date no data were found regarding the low vision rehabilitation outcomes using personalized advanced assistive technology in order to train patients with visual impairment. The development and use of innovative solutions represent the focuses of the personalized medicine-based model. Personalized medicine refers to a medical model that bring the citizen at the center of the care system to give an opportunity to look at new ways of delivering healthcare such as telemedicine for managing chronic conditions, mental health and mental promotion [17].

Aim of the Study

The aim of this prospective study was to preliminary evaluate in patients with central vision loss the efficacy of Eye-Fitness (NIDEK Technologies, Padua, Italy), a customizable computer-based rehabilitation program (CBRP), including exercises specifically and developed for performing in home visual rehabilitation training [18].

Methods

Participants

Nine patients with central vision loss were included in the study: 5 with a diagnosis of age related macular degeneration (AMD) and 4 with Stargardt's maculopathy (STGD). This prospective non-randomized study was performed on consecutive patients who were referred to the National Centre of Services and Research for the Prevention of Blindness and Rehabilitation of Visually Impaired. Patients included had a Best Corrected Visual Acuity (BCVA) between 1 LogMAR and 0.6 LogMAR and were clinically stable, without modifications from at least 6 months. One patient had monocular viewing because of a visual acuity of 1.5 LogMar in the other eye due to maculopathy. Patients are able to use the computer and no one had cognitive impairment. All participants wished for an improvement in their visual performance. Informed consent to participate in the study was obtained from all participants in adherence to the guidelines of Declaration of Helsinki.

Procedure

A standardized protocol of examination was performed in all participants, before and after in-home rehabilitation training, since one week, at our rehabilitation center by measuring: best corrected visual acuity, BCVA, evaluated with the Early Treatment Diabetic Retinopathy Study Charts (ETDRS) and it was expressed in LogMAR (logarithm of the Minimum Angle of Resolution) values at a distance of 4 meters with the best refractive correction; contrast sensitivity (CS), evaluated with the Pelli-Robson boards at 1meter distance adding +1 spherical diopters to the distance refractive correction; reading acuity (RA), evaluated with the Minnesota Reading (MNRead) Test charts at 25 centimeters adding +4 spherical diopters to the distance refractive correction and calculated as character print (cp); fixation stability, analysed using the MP-1 microperimeter, was quantified by calculating the area of a bivariate contour ellipse (BCEA) encompassing one standard deviation (1- S.D., 68.2%) and was calculated in degrees² using the Steinman's technique [17]. Also the changes of fixation location before and after home training was measured. Moreover, reading speed (RS) was evaluated binocularly by counting the number of words read in 1 minute on the IREST charts with the optical aid that allowed patients to read fluently, without making errors, the 0.6 M (5.9 character print) on MNRead charts. Most of the patients were able to read 0.6 M on MNread charts with high plus spectacles lenses. The MP1 microperimeter allows an automatic comparison between two fixation exams. The centroids of the two fixation exams trajecto-

ries were calculated and the distance in degrees between the two centroids was provided automatically. After the first tests all patients were asked to see back and rest without eyes closed until they were ready to proceed to the second test. The test-retest protocol, used for the repeated visual functional performance, was similar to the first. We obtained also the accuracy of exercise' execution from quantification of the percentage of correct answers provided by the patients to each exercise (%) and their reaction time (sec) for giving the solutions. The System Usability Scale (SUS) was used in order to obtain a subjective assessments of usability of the tool. The questionnaire consists of 10 items with five response options for respondents: from "Strongly agree" to "Strongly disagree". In order to calculate the SUS score, first of all it is needed to sum the score of each item. Then, for items 1, 3, 5, 7 and 9 the score contribution is the scale position minus 1, while for items 2, 4, 6, 8 and 10, the contribution is 5 minus the scale position. Moreover, it is requested to multiply the sum of the scores by 2.5 for obtaining the overall score of SUS. SUS scores have a range from 0 to 100.

In-home rehabilitation training

The in-home rehabilitation program was performed using Eye-Fitness (Nidek Technologies, Padua, Italy), a CBRP including 19 customizable exercises that was designed and developed for tele-rehabilitation training. Eye-Fitness consisted of two main software applications: one is used by patients to perform the training exercise and the other one used by the therapist to configure and visualize the data of executed exercises. The language used in the interface is Italian but it can be easily modified in English language. The main objective of the Eye-fitness patient' s application is to provide an easy way to perform vision training as showed in figure 1.

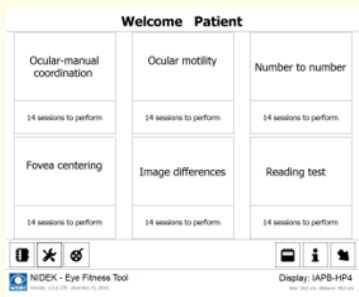


Figure 1 : Eye fitness home interface on the patients' computer screen containing the 6 exercises to perform.

The exercises were designed to rehab different visual functions. Setting and stimulus parameters (number, position, size, contrast) can be modified for each exercise in order to create a visual training plan tailored to every eye defects (Figure 2).

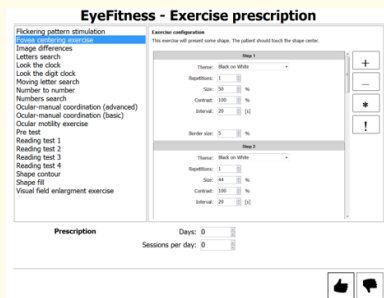


Figure 2: Eye-fitness exercises configuration. During the configuration the rehabilitator can select the exercise between those reported on the left part of the screen and then customize it according to size, contrast, number and repetition of the stimulus.

The CBRP resides in an USB pen drive containing stimulation results (accuracy and reaction time) consultable by rehabilitation therapist (Figure 3).

Index	Correctness	Contrast	Size	Precision	Answer time	Summary
1	75 %	50 %	100 %	29 %	00:11.7	Mean answer time 00:13.0
2	100 %	50 %	100 %	52 %	00:14.8	Correct answers 94 %
3	100 %	50 %	100 %	43 %	00:14.3	Wrong answers 5 %
4	100 %	50 %	100 %	54 %	00:15.1	Wrong answers 0 %
5	100 %	50 %	100 %	57 %	00:16.1	Executed steps 20/1
6	100 %	50 %	100 %	45 %	00:13.5	
7	100 %	50 %	100 %	72 %	00:13.7	
8	100 %	50 %	100 %	51 %	00:12.2	
9	100 %	50 %	100 %	69 %	00:12.7	
10	100 %	50 %	100 %	51 %	00:12.9	
11	100 %	50 %	100 %	60 %	00:10.1	
12	100 %	50 %	100 %	39 %	00:15.0	
13	100 %	50 %	100 %	57 %	00:12.3	
14	100 %	50 %	100 %	54 %	00:14.7	
15	100 %	50 %	100 %	60 %	00:13.0	
16	100 %	50 %	100 %	57 %	00:08.0	
17	100 %	50 %	100 %	49 %	00:09.2	
18	100 %	50 %	100 %	62 %	00:13.8	
19	100 %	50 %	100 %	63 %	00:14.0	
20	100 %	50 %	100 %	41 %	00:12.4	

Figure 3: Eye-fitness diary: it allows to visualize and analyze the data obtained from the execution of each exercise.

The home-training plan consisted of 6 exercises originally designed for macular degenerations:

1. Ocular-manual coordination, this exercise presented a symbol at random position with decreasing contrast
2. Ocular motility, the patient should recognize the presented E flickering symbols in a random position, the symbols decreased in size and contrast
3. Number to number, in this exercise the patient should connect corresponding numbers presented in 2 groups
4. Fovea centering, identifying the center of a spot. This exercise presented some shapes and the patient should touch the shape center
5. Image differences, identifying differences between two images. In this exercise patients should found the differences between two images
6. Reading test, reading a series of words presented in random order on the PC screen. In this exercise patients should read presented words and answer to proposed questions.

Patients underwent 14 visual binocularly home-training sessions, each lasting 45 minutes daily (Figure 4).



Figure 4: One patient performing the Ocular Motility exercise.

Each of the 14 training session consisted of all six exercises described before a pre-test, based on the projection of an E letter on the center of the screen, was required in order to configure the CBRP according to the visual acuity limit. The E letter randomly changes its orientation and, at the same time, it decreases in size if the patient was able to identify it correctly. According to the same procedure also contrast limit was recognized. Before delivering the USB pen drive, patients were instructed about the training task of each exercise in order to correctly perform it at home at a distance of 40 cm with their reading glasses. During the home training patients were asked to

report if the move near than 40 cm from the PC screen. Every exercises, excluding reading task, was presented on the screen for as long as the participants needed to give an answer.

Data analysis

Descriptive statistics were used to analyze the collected data described by means and standard deviations. Accuracy and reaction time data were automatically provided by the tool. The paired t test was used to detect changes in the data obtained before and after home training. One-way ANOVA was performed to analyze data per session. The p values less than .05 were considered statistically significant.

Results

Nine patients were enrolled for the training program and they had a mean age of 60 ± 17.2 years. Their demographic and clinical characteristics at baseline are shown in table 1. All participants completed the tele-rehabilitation program with a preference of black on white background of the CBRP.

ID	Age	Sex	Eye Disease	BCVA (LogMAR)		Binocular BCVA (LogMAR)	Reading Acuity (cp)		Reading Speed (WPM)
				Best Eye	Worse Eye		Best Eye	Worse Eye	
P1	77	M	AMD	0.7	0.8	0.8	23	25	45
P2	46	M	STGD	0.9	1.04	0.98	15	19	37
P3	30	M	STGD	0.6	0.8	0.7	3,7	25	103
P4	64	M	STGD	0.6	1	0.6	15	37	55
P5	71	F	AMD	0.8	1	0.9	23	25	30
P6	61	M	AMD	1		1	74		35
P7	76	M	AMD	0.7	0.8	0.68	15	19	50
P8	68	F	AMD	0.7	0.8	0.78	23	29	50
P9	48	F	STGD	0.7	0.8	0.75	23	29	51

Table 1: Patients clinical characteristic before starting Eye-Fitness.

BCVA remained unchanged after training both in the best eye, from 0.78 (± 0.2) LogMAR to 0.73 (± 0,2) (t (8) = 2.72, P > .05) and in the worse eye, from 0.87 (± 0.17) LogMAR to 0.8 (± 0,1) LogMAR (t(7) = 1.2, P > .05). Binocular VA remained unchanged from 0.79 (6/38, 20/125) (± 0.17) LogMAR to 0.73 (6/34, 20/112) (± 0.18) after training (t(8) = 1.2, P > .05). The mean CS resulted to be significantly improved from 0.5 (± 0.2) to 1.08 (± 0.3) LogC (t(8) = 6.1, P = .001) in the better eye and from 0.4 (± 0.5) LogC to 0.7(±)0.4 LogC, (t(7) = 2.9, P = .01) in the worse eye respectively. Moreover, an improvement was registered for reading acuity for both the better eye (from 23.9 (± 25.1) cp to 20.4 (± 15.8) cp t(8) = 5.69, P > .05) and for the worse one (from 26 (± 7.3) cp to 23.5 (± 5.4) cp t(7) = 1.02, P > .05), but did not reach statistical significance. Binocular reading performance, calculated as words per minute, increased from the average of 50.6 (± 26.9) to 67.6 (± 22.7) wpm (t(8) = 13.2 P = .001) and it was statistically significant. Statistically significant differences were also registered for fixation stability calculated as BCEA values for 1 standard deviation ellipse in both eyes. A more stable fixation was registered after rehabilitation and BCEA 68.2% was significantly smaller for both the better eye (from 8.87^{o2} (± 10.6) to 1 (± 1.79) (t(8) = 3.4, P = .004) and for the worse eye (from 10.6^{o2} (± 1.9) to 2.26 (± 0.69) (t(7) = 4.5, P = .002). Moreover, BCEA 68.2% values both for the better and the worse eyes before home training were compared with those after in-home rehabilitation as shown in figure 5.

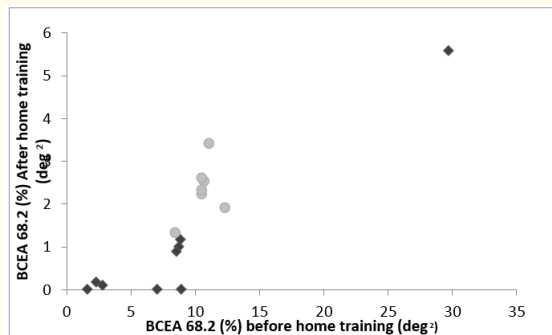


Figure 5: Comparison between BCEA 68.2% values before and after home training. The diamonds represent the best eye while the dots the worse one.

Mean fixation shift, calculated as the distance between the centroids of the two fixation exams, was of 2.9° (± 2.5) for the best eye while 3.08° (± 0.7) for the worse eye (Figure 6).

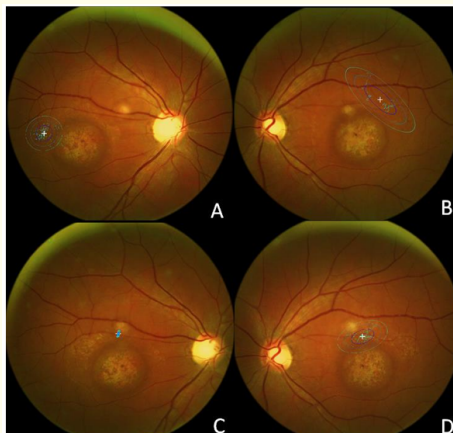


Figure 6A-6D: Fixation stability, quantified as BCEA encompassing 68.2% of fixation points, (dark blue circle) an PRL location superimposed on a retinal image for both eyes of one patient before (A, B) and after (C, D) training. Patient showed a change in the PRL location after training.

Mean accuracy in the detection of the stimuli was significantly better after training. The comparison between the first and last home training accuracy (from 52.3 (± 29.7%) to 84.9 (± 19.60%); $F = 45.30$ $P < .01$) showed a significant difference. Each patient’s accuracy data are plotted in figure 7A. The reaction time decreased significantly ($F = 80.5$, $P < .05$) from 35.7 ± 27.7 sec in the first training session to 9.3 ± 1.7 sec in the last session (Figure 7B).

According to the SUS questionnaire the 56% of the whole sample retained that Eye-fitness was “good”, 22% “OK fair”, 11% “Excellent”, 11% “Best imaginable”. In table 2 are shown the answer to the questionnaire given by the patient.

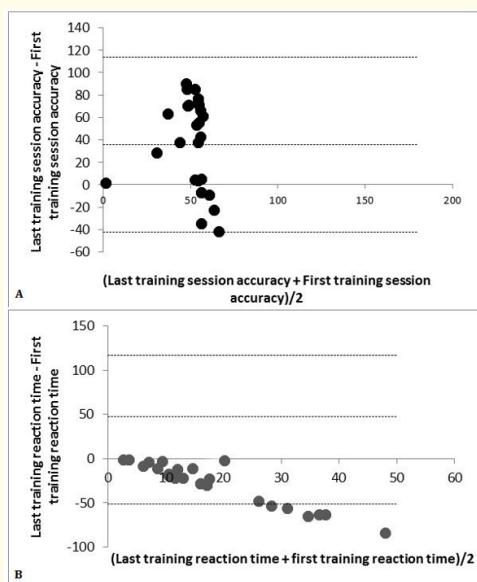


Figure 7A-7B: A Bland-Altman plot of the differences between the last and the first training accuracy (%) versus the mean of the last and first training showed a positive mean difference indicating an improvement during the last session (Figure 7A). Moreover, a negative mean difference indicates an improvement in reaction time (Figure 7B). The dashed lines represent the 95% confidence limits of the difference.

Items	Participants								
	1	2	3	4	5	6	7	8	9
1. I think that I would like to use this system frequently	4	3	5	4	5	4	4	4	3
2. I found the system unnecessarily complex	2	2	1	1	1	2	2	2	1
3. I thought the system was easy to use	4	4	4	4	5	4	4	3	4
4. I think that I would need the support of a technical person to be able to use this system	2	3	1	2	1	2	2	2	4
5. I found the various functions in this system were well integrated	4	4	4	4	5	4	3	4	5
6. I thought there was too much inconsistency in this system	1	1	1	2	1	1	2	2	4
7. I would imagine that most people would learn to use this system very quickly	4	4	4	4	5	3	2	4	3
8. I found the system very cumbersome to use	1	1	1	1	1	1	1	1	2
9. I felt very confident using the system	4	4	4	4	5	4	3	4	4
10. I needed to learn a lot of things before I could get going with this system	2	2	2	2	1	2	2	1	3

Table 2: SUS questionnaire patients’ answers scores.

The visuo-functional personal performance of test-retest for pre and post evaluation are summarized in table 3.

		Pre			
		Test 1	Test 2	Test 2-1	Paired t-test
BCVA	Best Eye	0,78 (0,2)	0,76 (0,2)	-0,02	>0,05
	Worse Eye	0,8 (0,17)	0,8 (0,18)	0	>0,05
Binocular VA		0,79 (0,17)	0,8 (0,15)	0,01	>0,05
Contrast Sensitivity	Best Eye	0,5 (0,2)	0,5 (0,22)	0	>0,05
	Worse Eye	0,4 (0,5)	0,4 (0,49)	0	>0,05
Reading Acuity	Best eye	23,9 (25,1)	24,1 (22,1)	0,2	>0,05
	Worse Eye	26 (7,3)	26,2 (7,8)	0,2	>0,05
BCEA (68.2%)	Best Eye	8,87 (10,6)	9,2 (8,6)	0,33	>0,05
	Worse Eye	10,6 (1,9)	11,3 (2,1)	0,7	>0,05
Reading performance		50,6 (26,9)	51,4 (23,4)	0,8	>0,05
		Post			
		Test 1	Test 2	Test 2-1	Paired t-test
BCVA	Best Eye	0,7 (0,2)	0,7 (0,1)	0	>0,05
	Worse Eye	0,8 (0,1)	0,8 (0,2)	0	>0,05
Binocular VA		0,73 (1,8)	0,76 (1,2)	0,03	>0,05
Contrast Sensitivity	Best Eye	1,08 (0,3)	1,1 (0,2)	0,02	>0,05
	Worse Eye	0,7 (0,4)	0,7 (0,3)	0	>0,05
Reading Acuity	Best eye	20,4 (15,8)	20,7 (14,9)	0,3	>0,05
	Worse Eye	23,5 (5,4)	23,7 (5,1)	0,2	>0,05
BCEA (68.2%)	Best Eye	1 (1,79)	1 (1,7)	0	>0,05
	Worse Eye	2,26 (0,69)	2,3 (0,9)	0,04	>0,05
Reading performance		67,6 (22,7)	68,9 (21,1)	1,3	>0,05

Table 3: Visual functional performance of pre and post test-retest evaluations.

Discussion and Conclusion

Eye-fitness home tele-rehabilitation program results a useful training option to rehab and improve visual functions in patients affected by macular degeneration. This new training program allows visually impaired subjects, due to central scotoma, to perform in their home environment a personal-designed visual training according to the patient’s specific pathology state. The CBRP presented in this study represents an innovation for visual rehabilitation purposes to overcome barriers to care through remote: patients can perform training at home without the presence of the rehabilitator optimizing the use of time. It’s portable and easy to use: a USB pen-drive with all the exercises inside. The advanced stages of both eye disease, AMD and STGD, cause a reduction in visual acuity, contrast sensitivity and stereopsis due to the development of an absolute central scotoma. Patients adopt a preferred retinal locus (PRL) in their peripheral retina used as pseudofovea with a loss of fixation stability that can contribute to a poor visual performance [4,3,19,20]. Reading become limited because of eccentric location of the PRL, instability of fixation, poor visual acuity, crowding effect of the peripheral retina and deficient eye movement control [21-23]. Visual training becomes necessary. Our rehabilitation program is designed in 3 phases: the first in the low vision center, with a face to face interaction with the therapist, the second at home without therapist but with a subsequent remote control and the third in the low vision center again after training. The visual training is based on the combination of eccentric view training, eye movement control training, visual exploration and discrimination tailored for every patient based on their threshold stimuli. As reported by other authors each approach mentioned is considered appropriate to compensate visual loss and reinforce visual functions [24,25]. Our study showed significant improvements in visual function parameters such as contrast sensitivity, fixation stability and reading performance providing the evidence of an effectiveness of the home rehabilitation intervention. BCVA remained unchanged, while reading acuity improvement doesn’t reach the statistical significance. Contrast sensitivity seems to be an important component of the visual system for

letter identification and face recognition and the improvement of this function could be related to the effect of training [26,27]. The improvement of fixation stability, resulted in a reduction of the BCEA values in both eyes, is likely to depend on the training that allows patient to be able to fixate with more accuracy. The findings obtained after training show that detecting and discriminating threshold stimuli resulted in a more precise fixation control; the use of a structured stimuli could increase the reactivation process of the PRL [28]. Moreover the customization of the software allows to use a highly significant recognition shapes as stimuli that could increase inner retina integration process and optimize stimulus processing and recognition with brain transmission facilitation in the same manner described about pattern stimulation technique [29]. Synaptic plasticity could improve vision according to vision restoration theory based on the repeated stimulation inducing a synaptic plasticity of a partially damaged structures and downstream areas [30-32]. During the EF exercises patients were requested to detect and discriminate visual targets, with a reduction of reaction time and an increase of accuracy. The reaction time significantly decreased from 35.7 ± 27.7 sec in the first training session to 9.3 ± 1.7 sec in the last session showing that the improvement is likely to be related to the visual training intervention. We found that reading performance improved significantly after training both in reading acuity and reading speed, evaluated with continuous text: patients at the end of the program can read an average of 67.6 wpm on the reading chart. As previously described perceptual learning, defined as "any relatively permanent and consistent change in the perception of a stimulus array, after practice or experience with this array" [33] through intensive practice can enhance visual function improving reading speed in AMD or STGD patients [24,34,35]. Moreover, Nguyen identified the eye movement control as a key role during reading [25]. We believe in a more integrated perceptual learning paradigm in which not only visual abilities alone but also their reciprocal influence with higher cortical functions during an active visual task can guide the oculomotor system towards the PRL. The consequence of these interactions results decisive for obtaining a good reading fluency of the text with a subsequent enhance of fixation stability and reading speed. This study for the first time, to the best of our knowledge, reported results about the efficacy of a home rehabilitation highlighting the importance of delivering services where rehabilitation centre is not locally available and addressing distance and transportation issues. Moreover, this new technique may contribute to avoid the issues related to attending a visual rehabilitation program for elderly age patients with transportation challenges and comorbidities. Most of the sample reported the ease of use of the tool because of the limited interactions with the computer that were needed to perform the visual training. All the participants said that they would like to use the CBRP beyond the study and have a similar system at home. Moreover, patients, found the exercises more enjoyable than the conventional rehabilitation technique and they felt that they were performing very up-to-date rehabilitation training. This finding is very important because of the adherence to the rehabilitation protocol for both patients and rehabilitators. Patients had also suggested some improvement: adding an auditory feedback to facilitating the understanding of some functions and monitoring themselves during the training session. This could increase motivation of patients to exceed the score obtained from one exercise to the next. All the suggestions were taken into account in order to apply future improvements to the CBRP. Positive reactions were collected from both visually impaired and rehabilitators, gathering the EyeFitness could become a valid tool also for Tele-rehabilitation purposes. This is important also for sustaining an healthy aging for visually impaired. Our home rehabilitation program seems to be easy to use and portable. It can be easily installed in every PC in few minutes. This technology could be a starting point for enhancing continuity of care and improving medical programs. In the future, we intend to test a more complex methodology in order to apply the tele-monitoring of the vision training with more interaction of the rehabilitator. This new training program allows visually impaired subjects due to central scotoma to perform, in their home environment, visual training resulting in a complete adherence to the intervention and compliance by the patients. The analysis of the correct execution of each exercise is an additional value of the tool. Moreover, Bittner and colleagues in a recent review reported no evidence on the flexibility of tele-rehabilitation for low vision patients but the results of this paper demonstrate that it is possible to remotely deliver rehabilitation services to visually impaired. Future research should evaluate the efficacy of the intervention in a larger cohort of patients with low vision due to other eye diseases as retinitis pigmentosa patients. Moreover, the implication related to the loss of contact with the rehabilitator (face to face interaction) should be investigated. In conclusion, no studies to date have investigated the tele-rehabilitation intervention in low vision patients. This study provides important information on the use of telerehabilitation in order to perform visual rehabilitation for patients with low vision.

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