Successful treatment of diplopia using prism correction combined with vision therapy/orthoptics improves health-related quality of life (#91160)

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Successful treatment of diplopia using prism correction combined with vision therapy/orthoptics improves health-related quality of life

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Background To track improvement in diplopia symptoms with strabismus-specific health-related quality of life (HRQOL) questionnaire across a treatment consisting of prism correction followed by vision therapy/orthoptics where the former was unsuccessful.

Methods. Forty-eight participants with diplopia (mean age = 62.45) completed an Adult Strabismus-20 (AS-20) questionnaire and a Diplopia Questionnaire (DQ) before and with prism correction. Inclusion criteria before prism diplopia was “sometimes” or worse for reading and/or straight-ahead distance. The success with prism treatment was clasified as diplopia as “never” or “rarely” perceive diplopia in the items for reading and straight-ahead distance in the DQ. The failure with prism correction was determine when diplopia worsened or remained the same. In any case (success or failure), average of initial AS-20 scores werw compared with score after prism correction, taking account the AS-20 subscales (reading and general functions, and self-perception and interaction). Participants in the failure subsequently underwent a vision therapy/orthoptics programme wearing their prism correction. The analysis of the treatment success or failure was again determined using the AS-20 questionnaire (before and after vision therapy/orthoptics).

Results. Forty-three participants completed the questionnaire at the follow-up visit. Prism correction was successful for 22 patients, and failed for 21. Those participants for whom the prism correction was classified as a success showed a statistically significant improvement (P=0.01) in both reading and general functions. In the failure group, there was no significant change in AS-20 score in any of the domains (P=0.1). Following vision therapy/orthoptics treatment, 13 of the 21 participants achieved binocular vision. This improvement was transferred to a statistically significant improvement in reading and general functions (P=0.01).

Conclusions. Vision therapy/orthoptics may be an option to achieve an improvement in diplopia symptoms where prism correction has proved unsuccessful. In the 81% of the patients prism correction and adicional visual therapy is correlated with enhance in strabismus-specific HRQOL, mainly in general functions and reading.

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Abstract

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Introduction

Globally, the prevalence of strabismus ranges from 2 to 4%.[1] Diplopia in adulthood is associated with strabismus[2] deriving from different aetiologies: decompensation of previous deviations (foria or tropia);[3,4] paresis or paralysis of extraocular muscles, whether vascular,[5,6] tumour-related[7] or secondary to brain trauma;[8] autoimmune diseases, such as Graves syndrome; or problems secondary to retinal diseases, such as dragged-fovea diplopia syndrome.[9]

The impact of strabismus on health-related quality of life (HRQOL) in adults can be assessed using different questionnaires such as the specific Adult Strabismus-20 questionnaire (AS-20),[10] or the more general American National Eye Institute Visual Functions Questionnaire (VFQ-25).[11] Predictably, the AS-20 is more sensitive than the VFQ-25 for detecting reduced HRQOL in adult strabismus.[12] A previous evaluation of the psychometric properties of the AS-20 with Rasch analysis proposed the reduction of the questionnaire to four distinct domains: self-perception (5 items), interactions (5 items), reading function (4 items), and general function (4 items).[13]

The impact of diplopia on quality of life has been analysed by different authors.[14] Holmes et al. designed the Diplopia Questionnaire (DQ) specifically to quantify diplopia,[15] allowing the position and distance at which the patient experiences diplopia to be recorded. Researchers have proven a high correlation between

the functional results of the AS-20 and measurements provided by the DQ in patients with diplopia in primary gaze and reading.

Regarding the effects of different strabismus treatments on HRQOL, a number of studies propose surgery as an option associated with significant and enduring functional and psychological improvement in patients with strabismus.[16,17,18] Moreover, all the evidence seems to indicate that these improvements in HRQOL are greater in diplopia patients than those without diplopia.[19]

Hatt et al.[20] studied the effects of prism correction in participants with binocular diplopia, achieving a 68% success rate measured with the DQ in participants with diplopia rarely or never perceived in primary gaze and reading. Improvement was also recorded in the reading and general functions subcategories of the AS-20, but did not extend to either the self-perception or interactions categories.[20]

Vision therapy/orthoptics) has proven its effectiveness in improving vergence ranges in patients with esotropia[21] and convergence insufficiency;[22] to the best of our knowledge, however, the effects on HRQOL of this treatment have never been evaluated. The aim of the present study is to assess the impact on the HRQOL of adults with diplopia of a protocol that involves prism correction and vision therapy/orthoptics as required.

Materials & Methods

Design

This is a prospective case series study. The participants were adults (>18 years old) with acquired diplopia, and all were patients at the Ikusgune Optometric Center and Begira Ophthalmologic Clinic (Basque Country, Spain). Patients with severe amblyopia (BCVA <0.2), monocular diplopia, nystagmus, and/or mental or cognitive impairments that would rule out the use of a HRQOL assessment, were excluded.

The study followed the tenets of the Declaration of Helsinki and was approved by the Basque Country Ethics Committee of Clinical Research (PI2021059). The participants signed a consent form after receiving a verbal and written explanation of the study.

Evaluation protocol

HRQOL assessments

The DQ provides a self-evaluation of diplopia severity on a five-point scale (never, rarely, sometimes, often, always) in seven gaze positions (reading, straight-ahead distance, right gaze, left gaze, up gaze, down gaze, and any other gaze position). According to the authors' criteria,[15] where participants rate diplopia perceived in reading and straight-ahead distance gaze positions as "sometimes", "often" or "always", this

should be included in the analysis. Prism correction success was defined as diplopia rated on the DQ as "never" or "rarely" for reading and straight-ahead distance. The validated version of the AS-20 questionnaire was also used.[13] Each of the four domains was scored independently and finally consolidated into a unique 0 to 100 score (worst to best HRQOL) to facilitate interpretation. Both the AS-20 questionnaire and the DQ were taken before and after prism correction, and at the end of the vision therapy/orthoptics where prism correction was rated unsuccessful.

Clinical evaluation

The participants were evaluated by an experienced optometrist. Refractive error was corrected, and best corrected visual acuity (BCVA) was obtained using the HOTV visual acuity chart with crowding bars (Smart4Vision, Spain). Binocular vision was analysed using the Worth Four Dot test at a distance of four metres with scotopic illumination, and the Random Dot Preschool Stereoacuity test (Stereo Optical Company Inc., United States) at near distance. Deviation angle was measured using two different procedures. The first of these was a cover test with an accommodative stimulus, at near and far distances, placing the prism over the strabismic eye, using stimuli based on characters two lines below the participant's BCVA. Where the strabismus combined horizontal and vertical deviations, the primary deviation was corrected first (e.g., the vertical deviation in 4th cranial nerve palsy). The second procedure involved the use of a synoptophore. Subjective and objective deviations were evaluated using a traditional synoptophore (Oculus, Germany), and a modern version based on virtual reality glasses with an eye tracker (VisionaryVR, VisionaryTool S.L., Spain). Deviations in cyclotorsion were measured with both synoptophore devices in addition to a Double Maddox rod test.[23]

The clinical evaluation included an ocular health exam (using tropicamide for pupil dilation), biomicroscopy, an indirect ophthalmoscope, and optical coherence tomography (insert model and manufacturer).

Treatment protocol

Treatment lasted from 1 to 4 months, with two well-differentiated phases (Figure 1).

Phase I. Prism correction

Fresnel prisms were prescribed at the first visit. Where the deviation was lower than 6 prism diopters (D), the prism was located over the participant's dominant eye. Where the deviation was higher than 6 D, the value was divided between two prisms, with the prism used in front of the dominant eye having twice the power of that used over the non-dominant eye.

After one month, at the follow-up visit the participant was required to complete both AS-20 and DQ questionnaires again. Where the participant rated the prism correction as successful (diplopia rated "never"

or "rarely" on the DQ for reading and straight-ahead distance), new glasses with the prism correction were prescribed. Where the prism correction was rated as unsuccessful (diplopia rated "sometimes" or "always"), the participant was included in phase II.

Phase II. Vision therapy/orthoptics

Vision therapy/orthoptics included exercise sessions at the centre and at home. The exercise sessions at the centre lasted for 2 months, with visits scheduled every 15 days (4 sessions in total), and used traditional orthoptics materials and instruments such as a synoptophore, anaglyphs and vectograms, and a Brock string with and without prisms. Gamified training exercises using the previously cited virtual reality synoptophore were also used at the clinic (VisionaryVR, VisionaryTool S.L., Spain).[24] Exercises at home were prescribed at the same time, also with a 2-month duration, consisting of 20 minutes per day, 5 days per week, of game play involving computerised vergence exercises with anaglyphs (Figure 2). Two similar programs were used: Vision Builder Version 2.7 for Windows (Haraldseth Software, Norway) and VisionaryTool (VisionaryTool S.L., Spain) (Figure 2).

Data analysis

Following Holmes et al.'s criteria,[15] prism treatment success occurs when diplopia is rated "never" or "rarely" in both reading and straight-ahead distance gaze positions. The mean with standard deviation of the AS-20 and DQ scores were calculated for the four domains before and after prism correction, and after vision therapy/orthoptics treatment where prism correction was rated a failure. The participants completed the questionnaires during the first visit, before prism correction or intervention of any kind. After prism correction, data were taken at the follow-up visit (after 1 month), irrespective of whether the prism power was changed. AS-20 questionnaire and DQ scores before/after prism correction and before/after vision therapy/orthoptics were compared using a Wilcoxon signed rank test, for the whole group and in sub-groups of success/failure, and according to the prism value. In addition, a chi-square test was performed to determine whether the success number was significant. Baseline differences between patients were also analysed, considering success or failure in both prism correction and vision therapy/orthoptics. Cronbach's alpha coefficient was used to evaluate the reliability of the scales used, despite the questionnaires having been previously validated for this purpose.

Results

A total of 48 adults (21 women and 27 men) with diplopia were recruited for the study, with a mean age of 62.45 ± 16.00 years old (within the age range 26 to 86 years). The baseline variables can be consulted in annexed 1 and 2. Eleven of the participants had received previous treatment to correct the diplopia: five of

these had been treated with botulinum toxin, three had undergone strabismus surgery, and another three had been treated with botulinum toxin followed by strabismus surgery.

The spheric refraction equivalent was –1.12 ± 4.29 D (-22.00 to 4.25 D range) for the right eye and -0.94 ± 4.28 D (-22.00 to 3.50 D range) for the left. Presbyopia was compensated in 37 subjects with a mean addition of 1.90 ± 1.10 D (1.50 to 3.00 D range). The best corrected visual acuity media in decimal acuity was 0.92 ± 0.16 (0.40 to 1.00 range) for the right eye and 0.92 ± 0.15 for the left (0.40 to 1.00 range). A Worth Four Dot test recorded results of diplopia in far vision in all participants except two, who achieved sensorial fusion (convergence insufficiency). Of the 48 participants, 32 (66.67%) patients were diagnosed as stereo blind in near vision; mean values were 914.60 ± 559.92" (arc seconds) within a 40" to 1300" range.

Thirty-four of the 48 participants showed paretic deviation, with paresis of the 4th (17) and 6th (17) cranial nerves; eight had a decompensated deviation (overaction of the superior oblique muscle or exotropia following esotropia surgery); four exhibited restrictive symptoms (scleral buckling for retinal detachment, myopic myopathy or thyroid surgery); and two had convergence insufficiency.

The left-right strabismus distribution was 22 participants (45.83%) with strabismus of the right eye, and 26 (54.17%) with strabismus of the left. Twenty participants (41.67%) had a pure horizontal deviation, (with no additional vertical deviation), 17 (35.42%) had an isolated vertical deviation, and 11 (22.91%) presented a mixed deviation.

The mean value of the horizontal deviation was 5.40 ± 6.58 PD (4 to 30 PD range) at far, and 4.26 ± 8.57 PD (4 to 30 PD range) at near distance. The vertical deviation mean value was 3.75 ± 4.55 PD (4 to 20 PD range) at far, and 3.85 ± 4.66 PD (2 PD to 20 PD range) at near distance. Excyclotropia deviation was 1.55 ± 2.76 degrees (2 to 10 degree range).

Initial visit and pre-prism correction results

The DQ results obtained prior to prism prescription (rated from 0 to 100, worst to best) indicated a mean of 64.01 ± 24.46 (22.50 to 100 rate range). Forty-five participants showed diplopia at far and reading distance; three experienced diplopia when reading only. Of these, perceived diplopia was reported when looking to the right (30 participants), to the left (34), upwards (26), downwards (30), and in intermedial positions (29).

Globally averages AS-20 scores before to prism correction were 51.39 ± 22.52 points in the general function domain, 53.50 ± 31.80 points in the reading function domain, and 89.30 ± 15.74 points and 86.31 ± 21.24 in the self-perception and interaction domains, respectively (Figure 3). The mean prism correction values were 7.73 ± 5.80 PD (4 to 30 PD range) at far, and 6.92 ± 7.05 PD (0 to 30 PD range) at near distance.

Post-prism treatment overall results

Five of the 48 participants did not complete the DQ at the end of the prism correction period (three dropped out of the study, one died, and one declined to wear the prism for work reasons but did attend the vision therapy protocol). Based on a priori definitions of success and failure based on participants' responses to the DQ, 22 of 43 participants (51%) were classified as prism correction successes and 21 (49%) as prism correction failures, ($P > 0.1$, according to chi-square analysis).

In all participants, mean AS-20 scores were statistically significant improved after prism correction compared to scores obtained prior to prism correction in both general function and reading function domains, improving from 51.39 ± 22.52 to 68.48 ± 24.12, and from 53.50 ± 31.80 to 68.66 ± 32.55, respectively ($P < 0.01$ in both). No significant changes in scores ($P > 0.1$ in both) were recorded in the self-perception and interaction domains (Figure 3).

Where the prism treatment was rated successful, new glasses with the prism correction were prescribed. At far distance, 5 subjects did not require a prism, while the mean prism power for the remaining subjects was 6.95 ± 6.13 PD, within a 2 to 30 PD range. At reading distance, 11 subjects did not require a prism, while the remainder were prescribed a mean prism power of 6.40 ± 7.66 PD, within a 3 to 30 PD range.

Before prism treatment, binocular vision tested with the Worth Four Dot test indicated 46 participants with diplopia and 32 with null stereoacuity. Following prism treatment, Worth Four Dot test results found 18 participants (37.5%) with null stereoacuity (mean scores 673.49 ± 567.88"; $P = 0.01$), and 18 patients with diplopia (mean scores 4.42 ± 0.50; $P = 0.01$).

Post-prism results: success or failure

The DQ results pre- and post-prism treatment indicated no significant differences in either the success or failure group ($P > 0.05$).

For the 22 participants for whom the prism treatment was a success, mean AS-20 scores significantly improved in the reading function domain, from 65.99 ± 32.39 to 86.45 ± 23.24 points after prism correction ($P = 0.01$); and in the general function domain, from 55.68 ± 22.96 to 83.32 ± 17.37 after prism correction

(P < 0.01). No significant differences were found in either the self-perception (P = 0.17) or interaction domains (P = 0.50), as shown in Figure 3.

In the 21 participants in whom the prism treatment was not effective, the mean AS-20 scores showed no significant improvement in any domain (P = 1.00). These participants were older, had a greater angle of deviation, and worse binocular vision (Table 1); they also obtained a higher score on the DQ and more symptoms on the AS-20 questionnaire (Table 2).

Post-vision therapy/orthoptics overall results

Phase II (Vision therapy/orthoptics) commenced with 22 participants: 21 from the prism treatment failure group plus 1 who declined to wear the prism correction; one participant dropped out. The treatment succeeded in 13 participants (62%) and failed in 8 (38%). The number of participants that experienced an improvement was not significant (P = 0.27, using a chi-square test). The DQ results pre- and post-vision therapy exhibit significative differences (P = 0.05).

Mean AS-20 scores significantly improved in the reading function domain, from 51.71 ± 29.19 to 72.78 ± 27.94 points after undergoing the vision therapy/orthoptics programme (P = 0.00); and in the general function domain, from 52.95 ± 20.07 to 67.54 ± 22.40 points after vision therapy/orthoptics (P < 0.01). No significant differences were recorded in either self-perception (P = 0.31) or interaction domains (P = 0.21), as shown in Figure 4.

Prior to vision therapy/orthoptics treatment, binocular vision tests showed 18 participants with diplopia and null stereoacuity. After vision therapy/orthoptics, only 5 participants exhibited with diplopia with the Worth Four Dot test (mean scores: 4.12 ± 0.32, P < 0.01), and all of them also exhibited null stereoacuity (mean scores: 427.90 ± 432.87"; P < 0.01).

After vision therapy/orthoptics, the prism power needed to achieve binocular vision was significantly lower at far (mean scores: 3.07 ± 5.80 PD; P < 0.01) and near distance (mean scores: 2.93 ± 5.66 PD, P < 0.01).

Post-vision therapy/orthoptics results: success or failure

For the 13 patients successfully treated with vision therapy/orthoptics, mean AS-20 scores significantly improved after undergoing the vision therapy/orthoptics programme in the general function and reading function domains. General function scores improved from 54.74 ± 21.45 points post-prism correction to 73.21 ± 20.36 points subsequent to undergoing the vision therapy/orthoptics programme (P = 0.02). Reading function domain scores improved from 57.79 ± 29.05 points post-prism to 85.09 ± 19.97 points post-vision

therapy/orthoptics (P = 0.01). No significant difference was found between pre- and post-vision therapy/orthoptics scores in the self-perception and interaction domains (P = 0.77 and P = 0.35, respectively), as shown in Figure 4.

For the 8 patients for whom vision therapy treatment was unsuccessful, mean AS-20 scores improved significantly in the reading function domain, from 41.83 ± 28.42 points post-prism correction to 52.77 ± 28.43 points post-vision therapy/orthoptics (P = 0.04). In the general function, self-perception and interaction domains, no difference was found between pre- and post-vision therapy/orthoptics scores (P = 1.00) for both domains, as shown in Figure 4.

Summary

The proposed treatment – prism correction followed by vision therapy/orthoptics as required – was successful in 35 participants, or 81% of the study sample (P < 0.01, using a chi-square test). In addition, the participants showed significant improvement in their binocular vision tested with the Worth Four Dot test, from 4.95 ± 0.20 to 4.12 ± 0.32 (P < 0.01); and in stereoacuity, from 914.60 ± 559.92” to 427.90 ± 432.87” (P < 0.01).

Discussion

In this study, prism correction alone solved the diplopia in 51% of patients. Where the prism correction was insufficient, the orthoptic/vision therapy prescribed resolved the diplopia in 62% of patients. Overall, the proposed treatment of prism correction followed by vision therapy/orthoptics as required was successful in 81% of patients.

Participants successfully treated with prisms improved in both the general function and reading function domains. These results are congruent with those obtained by Hatt et al.,[20] underlining the importance of prisms in the treatment of diplopia. Interestingly, those participants that failed to obtain stable fusion at far distance or when reading, according to DQ results, showed no significant improvement in either general or reading function domains. This result obtained in our study was also pointed out by Hatt et al.[20]

Those participants that continued with the vision therapy/orthoptics treatment also improved in both the general and reading function domains. Again, as with the prism correction, participants that showed no improvement on the DQ recorded no improvement on the AS-20 either. The lack of AS-20 improvement in participants classified as prism or vision therapy/orthoptics treatment failures suggests that the improvement recorded for the successfully treated participants was not attributable to a placebo effect.

Very few studies have studied the prism correction effect in adult subjects with diplopia.[25–27] Tamhankar and Ying[28] is a retrospective study in subjects with 4th cranial nerve palsy, classifing the prism treatment results into three categories (totally satisfied, mostly satisfied and dissatisfied). The analysis performed in this study, using a specific DQ and analysing the transference with the AS-20 HRQOL questionnaire, represents a step forward.

To the best of the author's knowledge, no previous study has analysed the impact of vision therapy/orthoptics treatment on the HRQOL of subjects with diplopia. Previous studies have evaluated how an improvement in vergence response transfers to diminished reading skills in subjects with convergence insufficiency.[29] Therefore, it makes sense that improvements in reading function should be obtained alongside improved binocular vision in diplopia subjects.

Baseline clinical differences between the success and failure groups were also analysed. Participants with severe diplopia, higher HRQOL symptomatology, worse binocular vision and higher deviation angle showed the poorest results after prism treatment. This result was not observed in Hatt et al.,[20] perhaps due to the fact that the present study included participants for whom surgery did not resolve the issue, with baseline deviations of > 10 PD. Since the higher the prism power, the greater the adaptation problems, participants in the present study were more likely to fail prism treatment in isolation. Following orthoptic/vision therapy, those participants needed lower-power prisms, facilitating adaptation and raising the likelihood of the final success of the treatment.

Where prism correction was insufficient, vision therapy/orthoptics resolved the problem in 62% of participants. There was a clear transference towards improved HRQOL, as in the case of prism success. Most of these participants had a history of strabismic surgery and/or botulinum toxin, hence prism treatment and orthoptic/vision therapy was the only remaining therapeutic option.

One participant declined prism treatment for work reasons, but opted to try vision therapy/orthoptics treatment, with a successful result. In future studies, it would be interesting to compare results obtained with only orthoptic/vision therapy versus prism treatment, particularly where refraction is not tolerated (e.g., severe anisometropia).[30]

Previous studies have demonstrated the effectiveness of vision therapy/orthoptics in convergence insufficiency,[31] but not, to the author's knowledge, in the case of diplopia. The present study sample included two participants with convergence insufficiency, but only one improved; importantly, the participant that showed no improvement had another condition that may have affected his prognostic:

Parkinson's disease. The prevalence of Parkinson's in adults with diplopia is high (18.1%).[32] Another participant with Parkinson's did achieve successful fusion using the prism. The success of the proposed treatment in Parkinson's sufferers is therefore deserving of future study.

The present study sample included participants with systemic diseases that increase the risk of depression. One of these participants, recently diagnosed with CREST syndrome, dropped out of the study. Hatt et al. (IOVS 2013;54: ARVO E-Abstract 5987) also describes how depression reduces self-perception of HRQOL in subjects with diplopia.

The use of new technologies and gamification strategies may contribute to increase motivation and compliance. Where new technologies are available both at the treatment centre and at home, with remote compliance and performance tracking, adherence to the treatment is increased, as previous studies have shown in cases of convergence insufficiency.[22]

This was a prospective study with 48 participants, making it reliable, but the authors are aware of a number of limitations. Firstly, the inclusion of a control group was opposed by the ethical committee in defense of research participants' interests. Nevertheless, placebo effects are unlikely to have occurred, since those participants who perceived diplopia after treatment did not report any improvement in HRQOL self-perception.

Secondly, the sample was heterogeneous. Most of the participants showed 4th and 6th cranial nerve palsy, while others exhibited different types of strabismus, such as convergence insufficiency in the geriatric population or childhood-onset esotropia. Childhood-onset esotropia usually exhibits high deviation angles, even sensory adaptations, that make treatment and prognosis challenging, and this may have had a statistical effect on this study.

Finally, an assessment of the stability of the improvements – six months after the end of the treatment, for example – would have been desirable.

Conclusions

Effective prism correction of diplopia is correlated with enhance in function-related HRQOL. Where prism correction fails, successful vision therapy/orthoptics treatment also improves function-related HRQOL. Prism correction together with vision therapy/orthoptics as needed offers a valuable non-surgical treatment option that could be particularly helpful in strabismus with small- and medium-angle.

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Figure 1

Flowchart of Methods section

Flowchart of proposed treatment of prism correction followed by orthoptic/vision therapy. The number of volunteers at each step includes the number of abandons or new inclusions in parentheses.

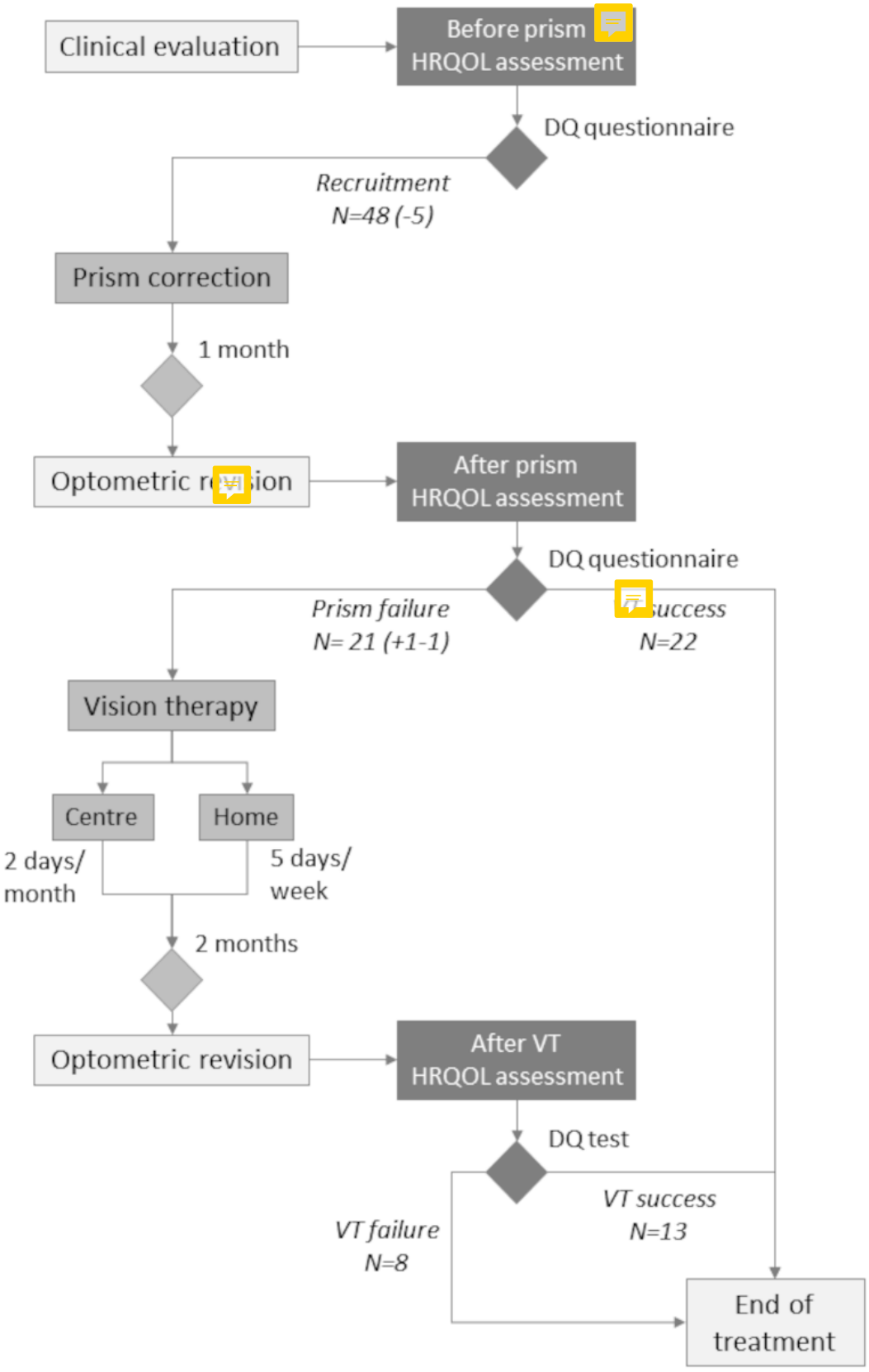
Clinical evaluation
Before prism HRQOL assessment
DQ questionnaire
Recruitment N=48 (-5)
Prism correction
1 month
Optometric revision
After prism HRQOL assessment
DQ questionnaire
Prism failure N= 21 (+1-1)
success N=22
Vision therapy
Centre
Home
2 days/ month
5 days/ week
2 months
Optometric revision
After VT HRQOL assessment
DQ test
VT failure N=8
VT success N=13
End of treatment

Figure 2

graphical example of the gamified visual therapy.

Logical process of the game . The participant’s task is to locate a ball situated at one of the four extremes of a cross (top, bottom, right or left). The program automatically adjusts the vergence difficulty during the training session. Where the participant responds correctly, the software will split the image into two anaglyph crosses which the participant must then merge using their own vergence system. Should the participant fail to respond correctly, the two crosses are merged by the program.

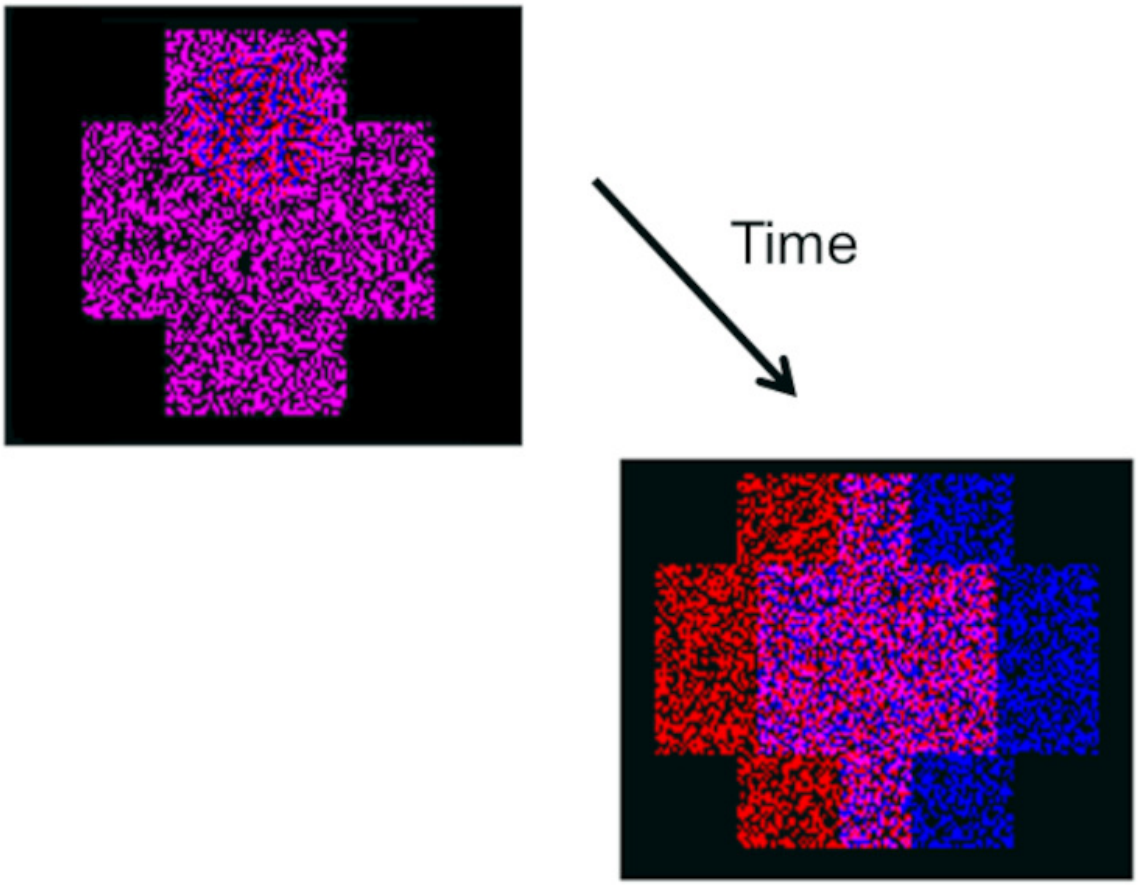
Time

Figure 3

Outcomes after prisma correction

Box and whisker plots of Adult Strabismus-20 Health-Related Quality of Life scores in participants with diplopia treated with prism. Clear line boxes show pre-prism scores and shaded line boxes show scores in prism correction. The centre line represents the median, lower and upper quartiles; the whiskers represent the extremes. Top (A): All participants; Centre (B): Successfully treated participants only; Bottom (C): Participants who failed prism treatment.

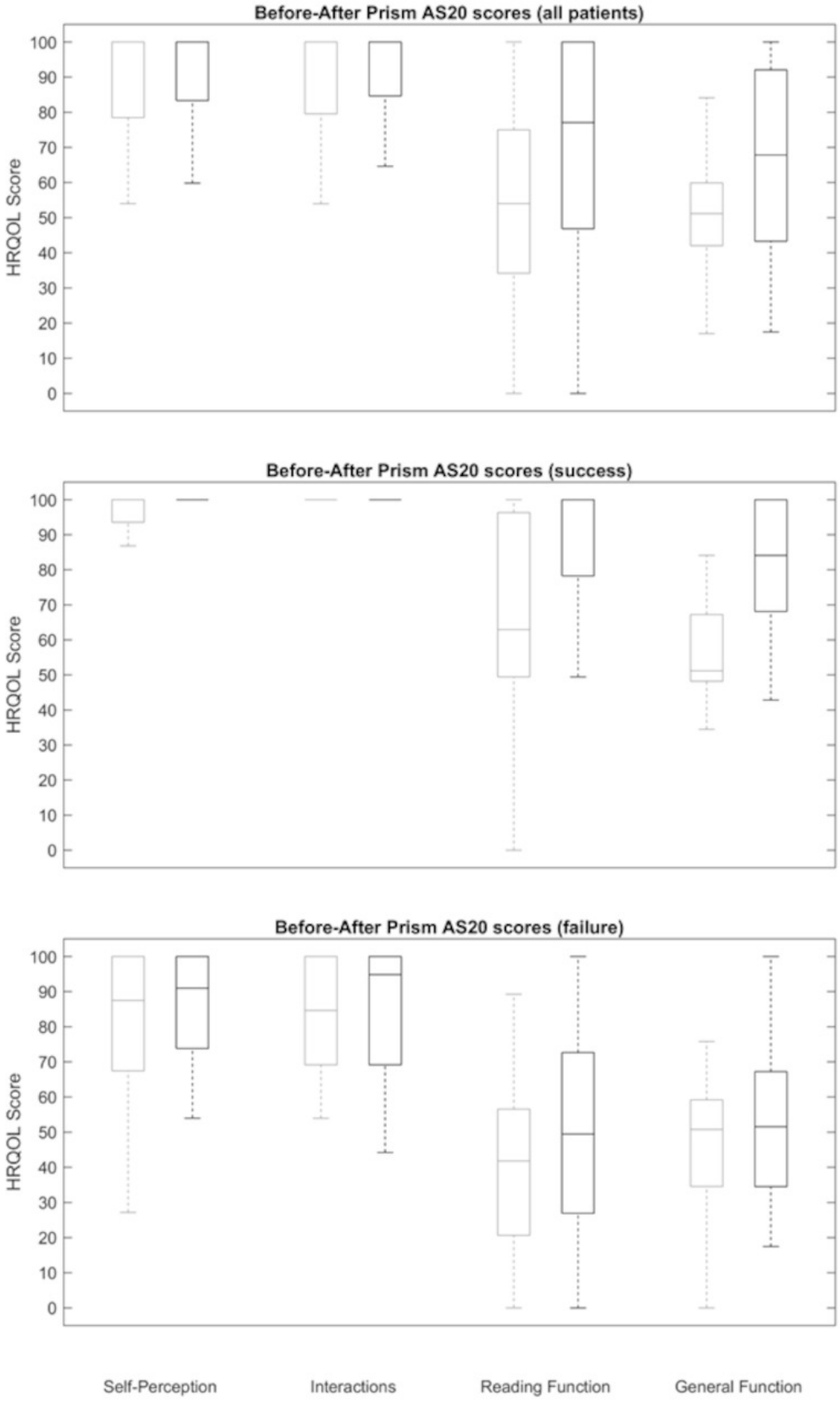
Before-After Prism AS20 scores (all patients)
HRQOL Score
Before-After Prism AS20 scores (success)
HRQOL Score
Before-After Prism AS20 scores (failure)
HRQOL Score
Self-Perception
Interactions
Reading Function
General Function

Figure 4

Outcomes after visual therapy treatment

Box and whisker plots illustrate Adult Strabismus-20 Health-Related Quality of Life scores in participants with diplopia treated with orthoptic/vision therapy. Clear line boxes show pre-orthoptic/vision therapy scores and shaded line boxes show scores after orthoptic/vision therapy. The centre line represents the median, lower and upper quartiles; the whiskers represent the extremes. Top (A): All patients; Centre (B): Successfully treated participants only; Bottom (C): Participants who failed prism treatment.

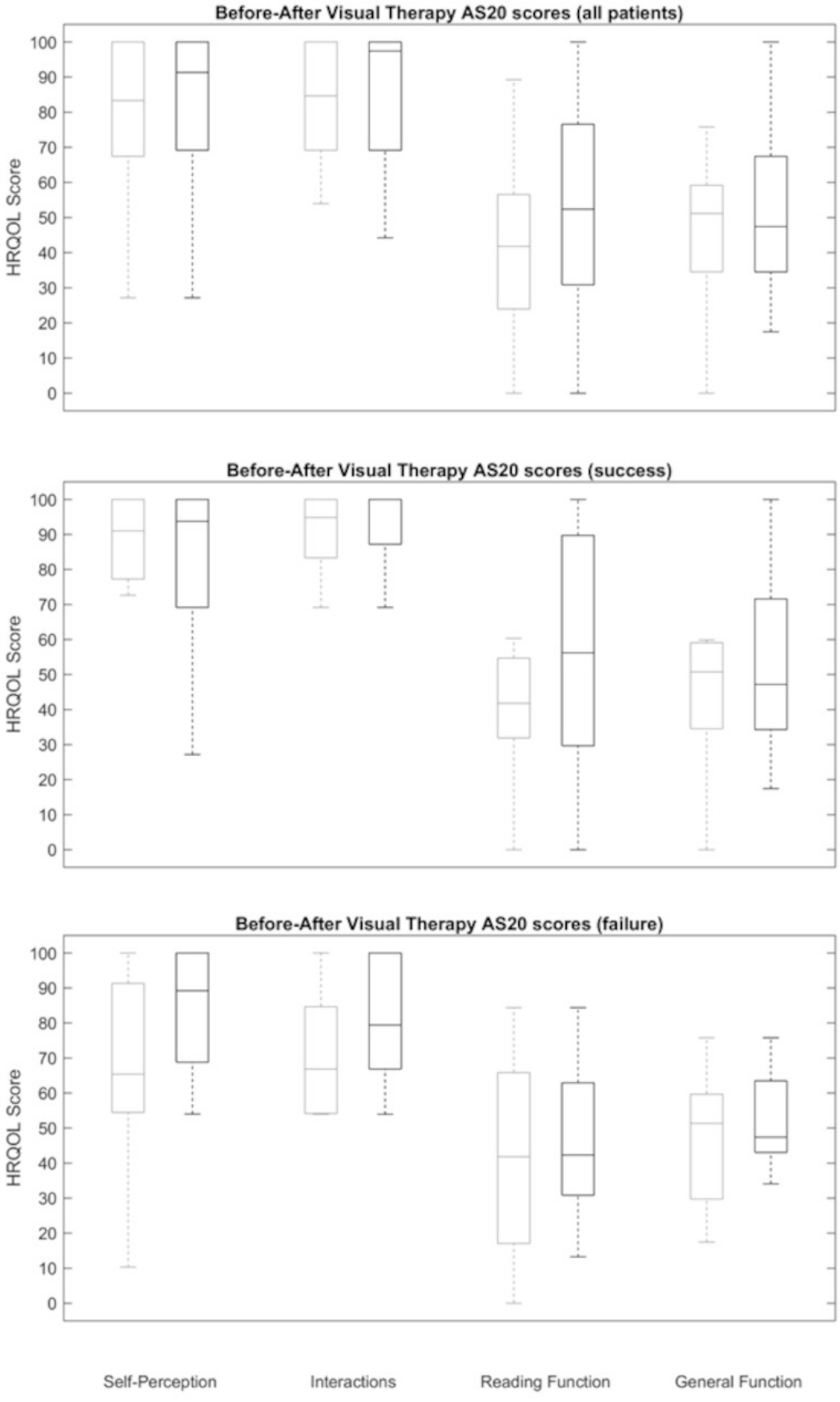
Before-After Visual Therapy AS20 scores (all patients)
HRQOL Score
Before-After Visual Therapy AS20 scores (success)
HRQOL Score
Before-After Visual Therapy AS20 scores (failure)
HRQOL Score
Self-Perception
Interactions
Reading Function
General Function

Table 1(on next page)

Results after prism treatment

Comparative analysis between success and failure groups. Statistical analysis performed using Mann–Whitney U test. Abbreviations: RE = right eye; LE = left eye; RPST = random-dot preschool stereo- acuity test.

Table 1. Comparative analysis between success and failure groups. Statistical analysis performed using Mann–Whitney U test. Abbreviations: RE = right eye; LE = left eye; RPST = random-dot preschool stereo- acuity test.

	Success group N = 22	**Failure group N = 21**	**P**
Age	70.09 ± 13.15	53.85 ± 15.39	<0.01
Refraction RE	-1.50 ± 4.88	-0.98 ± 4.09	0.51
Refraction LE	-1.22 ± 4.88	-1.01 ± 4.02	0.69
Visual acuity RE	0.88 ± 0.81	0.96 ± 0.8	0.41
Visual acuity LE	0.96 ± 0.81	±0.91 ± 0.169	0.57
Worth test	5	4.90 ± 0.30	0.14
RPST	607 ± 69	1219.5 ± 278.60	<0.01
Far strabismus horizontal deviation	3.65 ± 3.43	8.05 ± 8.61	0.16
Far strabismus vertical deviation	2.64 ± 3.82	5.05 ± 5.39	0.08
Near strabismus horizontal deviation	0.91 ± 2.52	8.57 ± 9.25	<0.01
Near strabismus vertical deviation	2.77 ± 3.93	5.43 ± 5.37	0.06
Torsional strabismus deviation	0.55 ± 1.26	2.52 ± 3.59	0.06
Far prismatic correction	5.85 ± 2.49	10.48 ± 7.59	0.03
Near prismatic correction	3.55 ± 4.04	11.33 ± 7.83	<0.01

Table 2(on next page)

symptomatology analysis

Comparative symptoms analysis of the two groups (success and failure) prior to prism correction, using the Adult Strabismus-20 questionnaire and the Diplopia Questionnaire. Statistical analysis performed with the Mann–Whitney U test.

Table 2: Comparative symptoms analysis of the two groups (success and failure) prior to prism correction, using the Adult Strabismus-20 questionnaire and the Diplopia Questionnaire. Statistical analysis performed with the Mann–Whitney U test.

Adult Strabismus-20 questionnaire	**Success group**	**Failure group**	**P**
Self-perception (0–100)	93.23 ± 13.74	79.07 ± 25.33	0.01
Interaction (0–100)	95.12 ± 11.82	83.21 ± 17.24	<0.01
Reading function (0–100)	65.99 ± 32.39	40.24 ± 25.90	<0.01
General function (0–100)	55.68 ± 22.96	46.89 ± 21.69	0.18
Diplopia Questionnaire	54.29 ± 26.09	72.33 ± 19.04	0.01