Eye Movements, Strabismus, Amblyopia and Neuro-Ophthalmology

Vergence Exercises for Six Weeks Induce Faster Recovery of Convergence Insufficiency Than Accommodation Exercises in School Children

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Received: February 8, 2021
Accepted: April 30, 2021
Published: May 21, 2021

Citation: Maagaard ML, Nisted I, Bek T. Vergence exercises for six weeks induce faster recovery of convergence insufficiency than accommodation exercises in school children. *Invest Ophthalmol Vis Sci.* 2021;62(6):23.
https://doi.org/10.1167/iovs.62.6.23

Purpose. Convergence insufficiency (CI) is characterized by abnormal vergence eye movement frequently accompanied by abnormal accommodation and subjective symptoms, such as headache, blurred vision, and diplopia. CI is treated with vergence and accommodation exercises that are integrated so that the relative contributions of vergence and accommodation exercises to the outcome are concealed. The purpose of the present study was to determine the individual contributions of vergence and accommodation exercises for the treatment of CI in school children.

Methods. In a prospective crossover study 44 children aged 9 to 13 years with CI were randomized to perform either vergence exercises followed by accommodation exercises each for 6 weeks or the 2 treatment regimes in the reverse order. The outcome measures were recovery from CI and the parameters vergence facility, positive fusional vergence, near point of convergence, monocular amplitude, and facility of accommodation.

Results. After the first 6-week period, full recovery from CI was significantly more frequent in the group commencing vergence exercises than in the group commencing monocular accommodation exercises ($p = 0.01$), whereas there was no significant difference between these proportions after the second 6-week period ($p = 0.45$). Vergence facility and positive fusional vergence improved significantly more after the period with vergence exercises than after the accommodation exercises, whereas there was no significant difference between the effects of the two types of exercises on the other studied parameters.

Conclusions. Vergence treatment induces a faster recovery of CI than accommodation treatment in school children. This may be used to improve compliance and success rate of the treatment.

Keywords: accommodation exercises, convergence insufficiency, orthoptic treatment, vergence exercises

Convergence insufficiency (CI) is a disturbance in binocular vision with a prevalence of 3% to 6% in school children[1,2] leading to symptoms such as headache, asthenopia, blurring, diplopia, and a possible negative impact on academic performance.[3] The clinical examination shows receded near point of convergence, reduced positive fusional vergence, and larger exodeviation at near than at distance.[4] Several studies have shown that school children diagnosed with CI have abnormal accommodation,[5,6] which is reflected in clinical guidelines for the treatment of CI that include exercises for both monocular accommodation and vergence, the latter including exercises for antisuppression and awareness of diplopia.[7] The effect of exercises aimed at improving vergence is assessed by measuring positive fusional vergence, vergence facility, and near point of convergence, whereas the effect on accommodation is assessed by measuring amplitude of accommodation and accommodation facility.[8] It has been shown that these measures of vergence and accommodation develop independently of each other in the age group of 7 to 15 year olds.[9,10] This suggests that clinical interventions can be performed separately on the individual elements characterizing CI, thereby possibly reducing the duration of orthoptic treatment required to obtain normal binocular vision.

Therefore, the present prospective randomized crossover study was performed with two groups of school children aged 9 to 13 years with CI randomized to perform either vergence exercises followed by accommodation exercises for each 6 weeks or the 2 treatment regimes in the reverse order.

Methods

Study Design

The study was designed as a prospective single site randomized crossover study of 44 children with CI randomized to perform vergence exercises followed by accommodation exercises or the reverse.

Recruitment

By January 2016, the 6 public schools in the municipality of Randers, Denmark located nearest to the Danish College of Optometry and Visual Science (DCOVS) were contacted by e-mail and offered a preliminary examination for CI of children aged 9 to 13 years. Four of the schools representing 755 children returned a positive answer and passed the offer to the parents. None of the families declined participation, and a primary examination consisting of a measurement of the near point of convergence (NPC), positive fusional vergence at 40 cm (PFV), and unilateral cover test was performed in all children at a designated time during school hours. This revealed 69 children with signs of CI (NPC > 10 cm and PFV < 20 prism diopters [pd]) who were offered an extended examination at DCOVS to confirm the diagnosis. Among these, 62 children (89.9%) turned up for the study.

Examination Protocol

The baseline examination consisted of the following[11]:

1. Monocular and binocular high-contrast Early Treatment Diabetic Retinopathy study (EDTRS) visual acuity was measured at 6 m (Topcon CC-100XP) and at 40 cm (Precision Vision, Cat. No. 2107).
2. Cycloplegic (cyclopentolate, 1%) and noncycloplegic autorefraction was measured using a Topcon TRK-2P Kerato-refractometer. Cycloplegic refraction was used to rule out uncorrected ametropia.
3. Unilateral and alternating prism cover test was performed at 6 m and 40 cm while the child viewed a 6/9 (0.2 logMAR) and 0.4/0.6 (0.2 logMAR) letter, respectively.
4. Ocular motility test was performed to rule out paralytic or restrictive deviations.
5. NPC was measured in centimeters with a Royal Air Force (RAF) ruler and a nonaccommodative target (a vertical line), which was moved slowly toward the child's nose until diplopia was reported, or loss of fixation was observed.
6. PFV was measured at 40 cm while the child viewed a vertical row of 0.4/0.6 line (0.2 logMAR) letters and while the demand on fusional vergence was gradually increased by use of a prism bar until either diplopia was reported or eye movement toward the base of the prism observed. If the child perceived the letters as blurred prior to loss of fusion, the blur value was recorded.
7. Vergence facility (VF) was measured at 40 cm for 1 minute using a 12 pd base out and 3 pd base in flipper while the child viewed a vertical row of 0.4/0.6 line (0.2 logMAR) letters, and the number of cycles per minute was recorded.
8. Monocular accommodation amplitude (MAA) was measured twice using an RAF ruler by slowly moving a horizontal line consisting of 0.4/0.6 (0.2 logMAR) letters toward the child until the first sustained blur was reported. To increase precision, the result was measured and recorded in cm and subsequently converted to diopters during initial data analysis.
9. Monocular accommodation facility (MAF) was measured at 40 cm for 1 minute using a ± 2.00 accommodative flipper while the child viewed a vertical row of 0.4/0.6 (0.2 logMAR) letters, and the number of cycles per minute was recorded.
10. The frequency of symptoms related to reading and other types of close work was assessed with the Convergence Insufficiency Symptom Survey (CISS), which has been validated for children aged 9 to 18.[12–14] The questionnaire consists of 15 items related to frequency of eye and visually related symptoms. Questions were read aloud to the child by the examiner. The child selected 1 of 5 possible answers scored on a scale from 0 (never) to 4 (always). The sum of scores was calculated (from 0 to 60); a higher score representing more frequent symptoms.

All measurements of visual acuity, vergence, and accommodation were performed with habitual correction, if any.

In 50 of the 62 (80.6%) children, the examination confirmed the presence of CI defined as: CISS score > 15, NPC ≥ 10 cm, exophoria at least 4 pd larger at near than at distance, and PFV ≤ 20 pd or failed Sheard's criterion (PFV less than twice the near phoria), and the diagnosis was confirmed at a re-examination 1 to 2 weeks later.

Exclusion criteria were:

- Visual acuity > 0.1 logMAR (6/7.5).
- Clinically significant uncorrected ametropia (difference between cycloplegic refraction and habitual correction exceeding 0.5 D of myopia or 0.75 D of hypermetropia, astigmatism, or anisometropia).
- Manifest comitant or incomitant strabismus.
- Systemic diseases, such as diabetes, metabolic disorders, or ocular pathology, reported by the parents.

Four children were excluded, 2 because monocular visual acuity was lower than 0.1 (logMAR), 2 because of uncorrected hypermetropia ≥ 1 D. This left 46 children as potential participants in the study. Among these, the parents of 44 children consented to let their children participate. Recruitment was started by March 2016 and continued until October 2018 when all 44 children had been included. Two of the children were subsequently excluded due to violation of the treatment protocol and one due to dropout leaving 41 children to complete the study. The clinical data at baseline are shown in the Table.

The calculation of sample size assumed a power of 80%, a *p* value of 5% and was based on standard deviations and clinically significant differences in NPC, PFV, VF, MAA, and MAF reported by the Convergence Insufficiency Treatment Trials (CITT) study group[5,15,16] and resulted in a minimum requirement of 18 persons to each of the 2 treatment regimes.

Randomization

The children were randomized to perform either 6 weeks of vergence exercises followed by 6 weeks of accommodation exercises or the reverse. Each of the two 6-week treatments consisted of three 2-week phases (Fig. 1). Every 2 weeks, the children came to the clinic at DCOVS for evaluation and exercises for the next phase were demonstrated and practiced.

At the end of each instruction session, the participants were required to demonstrate the procedure. Families were given written instructions including contact information in case of uncertainties about the procedures. A logbook was delivered in order to enforce home adherence, and all equipment necessary for homebased exercises was provided by DCOVS.

Table. Baseline Characteristics of the Participants in the Two Groups

Sex (F/M)	13/7	13/8	0.84
Distance exophoria (prism diopters)	0.21 ± 0.72	0.17 ± 1.04	0.86
Near exophoria (prism diopters)	4.8 ± 2.58	6.35 ± 2.67	0.04
Near point of convergence (cm)	23.7 ± 10.6	27.5 ± 11.0	0.26
Positive fusional vergence (prism diopters)	9.3 ± 4.3	11.4 ± 4.5	0.12
Vergence facility (cycles per minute)	5.8 ± 4.8	3.1 ± 4.0	0.05
Monocular amplitude of accommodation (diopters)	5.9 ± 2.2	5.1 ± 2.4	0.30
Proportion with accommodation insufficiency	17/20	18/21	0.68
Monocular accommodative facility (cycles per minute)	4.2 ± 4.5	4.1 ± 4.4	0.96
CISS (symptoms)	24.0 ± 8.1	24.0 ± 9.3	0.99

Continuous variables are represented as mean ± SD.

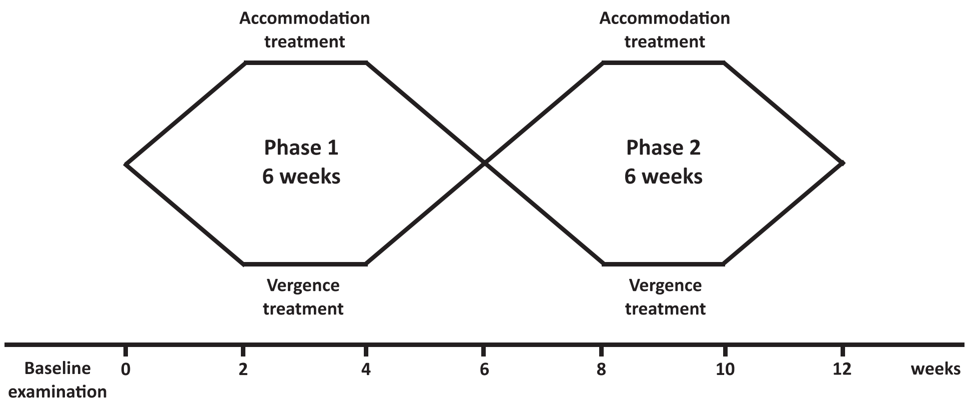

Figure 1. The study design.

The examination protocol was repeated at all instruction sessions, except for CISS that was only assessed at week 6 when the treatment regime was changed and after completion of treatment at week 12.

Each instruction session lasted approximately 45 minutes, including the evaluation of progress and instruction. The treatment program required that the child spent 20 minutes per day, 5 days per week performing exercises at home. This corresponded to a total of 25 hours during the 12-week treatment program. All exercises were performed as suggested by the CITT study group.[8]

Vergence Exercises

All vergence exercises were performed binocularly while the children wore their habitual correction, if any. The vergence exercises were designed to change vergence stimulus by inducing retinal disparity by use of prismatic lenses, dissociative colored filters (one and two-layer tranaglyphs), chiastopic/orthopic fusion (aperture ruler and eccentric circles), change in viewing distance, or combinations of these.

The basic principle of all vergence exercises was to increase or decrease convergence by inducing crossed and uncrossed diplopia while maintaining accommodation at a fixed distance by use of small optotypes or pictures providing feedback to the accommodative system. During all procedures, both vergence and accommodation loops were closed providing feedback for both accommodation and vergence systems, and stimuli to the two systems were separated in visual space. Exercises were aimed at increasing vergence amplitude, velocity, and precision. For further details see Appendix 1.

Accommodation Exercises

All accommodation exercises were performed monocularly with an eye patch covering one eye and subsequently repeated with the patch covering the other eye, with a progression from simple to more difficult levels of the procedures. The children wore their habitual correction, if any. The accommodative exercises were designed to induce hyperopic or myopic retinal defocus either by use of lenses or altering viewing and/or vertex distance. The eye patch ensured that the vergence loop was open by cancelling the sensory feedback to the vergence system. The exercises aimed at increasing monocular accommodative amplitude, velocity, and precision. For further details see Appendix 2.

Ethical Approval

The study adhered to the tenets of the Declaration of Helsinki and was approved by the Danish Data Protection Agency (J.nr. 2012-41-0637) and the Regional Ethical Comity (Central Region Denmark; 1-10-72-274-15). All parents gave written informed consent.

Outcome Measures

The primary outcome measure was the proportion of patients with full recovery at weeks 6 and 12 (i.e. CISS score below 16, NPC below 10 cm, and PFV more than 20 pd). Improvement was defined as a CISS score of less than 16 or

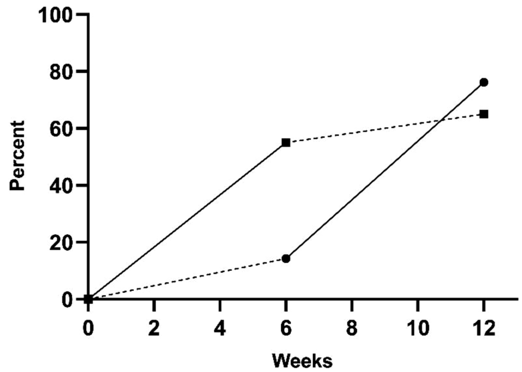

Figure 2. The percentage of patients with full recovery after 6 and 12 weeks in the 2 groups. The dashed line represents monocular accommodation exercises whereas the solid line represents vergence exercises.

a 10-point decrease combined with at least one of the following: normalized NPC, an improvement in NPC of more than 4 cm, normal PFV, or an increase in PFV of more than 10 pd. Children who did not meet criteria for either full recovery or improvement were considered nonresponders.

Secondary outcome measures were changes in CISS score and vergence and accommodation parameters.

Statistical Analysis

Data entry, validation, and analysis were performed in Stata SE version 16 (College Station, TX, USA). The baseline parameters in the two groups were compared using *t*-test for continuous variables and χ^2 test for proportions. There were no significant differences between the proportion of boys and girls between the two treatment groups, and no significant differences in any of the variables between the two genders. Hence, the data was not stratified according to sex. The proportion of participants with full recovery was stratified by treatment group and calculated at the change of treatment regime (week 6) and when treatment was completed (week 12) and was analyzed using logistic regression with adjustment for baseline measures that significantly differed between treatment groups and therefore adjusted *p* values were reported.

Changes from baseline at each examination and between treatment regimens for NPC, PFV, VF, MAA, MAF, and CISS were analyzed using 2-way repeated measures ANOVA and Greenhouse-Geisser correction was applied to adjust for sphericity.[17] Comparison of baseline measures between children with and without full recovery showed no significant differences ($p > 0.3$ for all comparisons), hence the 2-way repeated measures ANOVA was not adjusted for the baseline level. Post-tests to assess change from one examination to the following examination and between treatment regimens at each time of examination were performed using paired and unpaired *t*-tests, respectively.

Results

Figure 2 shows the proportion of participants in the 2 treatment groups who obtained full recovery after 6 and 12 weeks. After 6 weeks, full recovery was significantly more frequent in the group commencing vergence exercises (11/20) than monocular accommodation exercises (3/21; $p = 0.01$), whereas there was no significant difference between these proportions after completion of the treatment at week 12 (13/20) versus (16/21; $p = 0.45$). This indicates that the effects of the two types of exercises had been additive and independent of the order in which they were given. Partial recovery was obtained in 17% (7/41) of the participants and 12% (5/41) were nonresponders.

Figure 3 shows the effect of the interventions on the individual parameters used to assess the treatment effect. Left: The two vergence parameters vergence facility and positive fusional vergence improved significantly more with vergence exercises than with accommodation exercises ($p < 0.015$ for both comparisons), whereas there was no significant difference between their effect on the near point of convergence ($p = 0.07$). Right: There was no significant difference between the effects of the two interventions on the two accommodation parameters ($p > 0.2$ for both comparisons). For all parameters, the total effect after 12 weeks was independent of the order in which the exercises were performed.

The frequency of symptoms (CISS) was significantly reduced ($p < 0.001$), but with no significant difference between the two treatment regimens ($p = 0.9$). The mean difference in CISS score improved significantly from baseline to week 6 and from weeks 6 to 12 for both treatment groups but the difference between the 2 groups was less than 0.5 at baseline, week 6, and week 12 ($p > 0.86$ for all comparisons; data not shown).

Discussion

To the authors' knowledge this is the first study to evaluate and compare the effects of vergence and monocular accommodation exercises in children with CI. The overall success rate of 71% after 12 weeks was comparable to previous studies in which vergence and monocular accommodation exercises had been combined for the entire treatment period.[7] Among the participants with partial recovery and among nonresponders, the improvement of objective measures (82.4%) was better than that of subjective measures (52.9%; data not shown) suggesting that acquired oculomotor skills may have required conscious efforts with a consequent induction of fatigue.[18,19] This suggests that an extension of the treatment period beyond 12 weeks might have been beneficial for a minority of the children. In spite of this, one participant showed no effect of the treatment. Whether the lack of response in this one subject reflects a special disease entity remains to be elucidated. The study was conducted for 12 weeks and therefore the long-term effect of the instituted treatment is unknown. The results of other studies support that the effect of treating CI with vergence and monocular accommodation exercises is sustained after 1 year.[20] Furthermore, neuroimaging has shown increased activity in cortical areas involved in oculomotor control 1 year after successful orthoptic treatment of CI[21] and reduced activity in cortical areas involved in attention as an indication of a reduced need for conscious effort once oculomotor skills have been automatized.[22] In order to test these hypotheses, follow-up examinations are planned for the participants of the study.

Our findings suggest that parameters related to monocular accommodation were improved by exercises aimed at treating vergence abnormalities and vice versa. This might be explained as a consequence of both types of exercises stimulating both vergence and accommodation, although the

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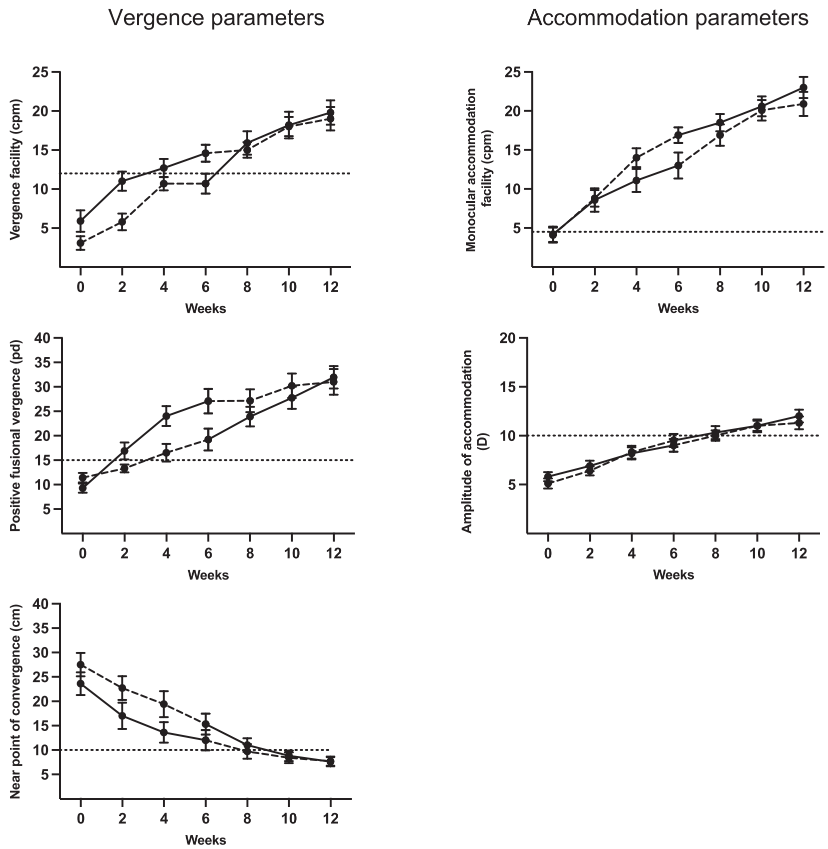

Figure 3. The effects (mean ± SEM) of vergence exercises (solid lines) and monocular accommodation exercises (dashed lines) on vergence parameters (left panels) and monocular accommodation parameters (right panels). The horizontal dotted lines represent the diagnostic cutlines for normal/abnormal values of each parameter.

underlying mechanism may differ. Thus, vergence exercises stimulate both systems directly whereas monocular accommodation exercises stimulate accommodation directly and vergence eye movement indirectly in the occluded eye but without feedback to the vergence system.

Although vergence and accommodation loops can be opened by occlusion and nonaccommodative targets,[23] the interaction between the two systems cannot be completely cancelled out due to their neurological coupling, hence it is less likely that exercises targeting each of the systems separately can be designed.

The finding that vergence exercises induced a more rapid recovery of positive fusional vergence and vergence facility may be due to the fact that these parameters require an adaptive response to recalibrate the interaction between vergence and accommodation implying that adaptive ability is essential for efficient improvement of the vergence system.[24,25] The positive effect of monocular accommodation exercises on vergence parameters may be explained by a more rapid and precise accommodation, which improves performance during vergence assessment. The similar recovery rate observed for NPC with both types of exercises could be due to similar stimulus demands to vergence and accommodation during assessment of NPC.

All monocular accommodation parameters improved independently of the treatment regime. Although monocular accommodation exercises are a direct treatment of accommodation dysfunction, the effect of vergence exercises on accommodation parameters could be explained by the fact that vergence exercises stimulate both vergence and accommodation to maintain single and clear vision. Similarly, the identical improvement of subjective symptoms resulting from the two treatment regimens suggests that parameters that can be measured objectively must normalize before subjective symptoms disappear. Also of relevance, there was no difference in the effects of the two treatment regimens at the end of the 12-week treatment period. This study corroborates previous findings[5,6] that a vast majority of children with CI have accommodation insufficiency, which according to clinical guidelines should be treated with a combination of vergence and accommodation exercises.[8] The similar rate of recovery of monocular accommodation parameters in the two treatment groups imply that vergence exercises and monocular accommodation exercises are equally efficient at treating accommodation insufficiency. However, this requires further investigation.

The treatment phases in the present study lasted 6 weeks, and since the effect on the studied parameters had not leveled out at that time, it cannot be excluded that a continuation of each of the interventions alone might have resulted in an effect similar to that obtained by the two treatment regimens applied in succession. An evaluation of the effects of the interventions with a longer follow-up should be the subject of a future study. The study has shown that vergence exercises are a more efficient approach to treating CI in school children in the short term, both by the higher proportion of patients achieving recovery and by the faster onset of the effect.

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The finding that vergence exercises accelerate improvement for children with convergence insufficiency has the potential to improve compliance with treatment and thereby long-term outcome.

Acknowledgments

Supported by The Synoptik Foundation and The VELUX Foundation.

Disclosure: **M.L. Maagaard,** None; **I. Nisted,** None; **T. Bek,** None

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Appendix 1: Vergence Exercises

Each exercise was performed for 6 minutes with children wearing their habitual correction, if any.

Phase 1

Brock's String. The child held a 250 cm long string with 3 beads placed at 50, 150, and 250 cm stretched from a door handle to the chin. The child was asked to fixate each bead for 5 to 10 seconds while the string was perceived in physiological diplopia with the 2 strings crossing through the bead. Once this was achieved with each bead, the bead at 50 cm was moved closer in steps of 10 cm.

Prism Flippers. The child viewed 0.4 logMAR letters at 40 cm and a pair of 1.5 pd base in lenses was placed in front of the eyes and once clarity and single vision was obtained letters were read for 5 to 10 seconds, followed by replacement with a pair of 6 pd base out lenses. If clarity or single vision could not be obtained the power of the lenses was reduced by 50 percent.

Aperture Ruler. The child was seated at a table with an Aperture Ruler (Bernell Corporation, catalog no. BC1050BK), which consists of a ruler-like apparatus, a plastic slide with a single aperture, and 12 cards with varying convergence demands. The child was asked to look through the aperture and to fuse the two pictures into a single and clear image, report perceived depth in the eccentric rings, and that the two suppression control objects were seen. Once all these tasks could be achieved, the convergence demand was increased by proceeding to the next card.

Phase 2

Aperture Ruler. Level 2

The procedure described in level 1 was repeated and the child was additionally asked to vertically align the cross and dot thereby reducing horizontal fixation disparity to zero.

Tranaglyphs. Level 1

The child was provided with variable tranaglyphs (Bernell Corp. card no. 601/605/607) and a pair of red-green glasses. The child was instructed to view the picture and then asked to slowly move the green sheet toward the green glass to increase convergence demand while keeping the objects clear and single for as long as possible. When the child was no longer able to fuse the picture, the level of difficulty was decreased by moving the sheets in the opposite direction.

Eccentric Circles. Level 1

The child viewed a card with 2 sets of eccentric circles separated by 6 cm at a distance of 40 cm and held a pencil approximately midway between the eyes and the card. The child was asked to fixate on the pencil so that the card was seen in physiological diplopia and to move the pencil back and forth until the middle two sets of circles were fused into one. Subsequently, the child was asked to report perceived depth in the eccentric circles and to see the 0.3 logMAR letters in the circles clearly for 10 seconds and then to look away.

Phase 3

Aperture Ruler. Level 3

The procedure described in level 2 was repeated with the addition that all stages were performed while vergence flippers with a total of 3 pd base in and 12 pd base out were alternatingly placed in front of the eyes.

Tranaglyphs. Level 2

The child was provided with a pair of red-green glasses and nonvariable tranaglyphs with vergence demands in nine steps (Bernell Corp., card no. 51/53/56). The child was instructed to view the picture with the lowest vergence demand and obtain clear and single vision for 10 seconds and then proceed to the next picture. When the child was no longer able to fuse the pictures, the exercise was repeated from the beginning.

Eccentric Circles. Level 2

The procedure described in level 1 was repeated, and difficulty was increased by reducing the letter size to 0.2 logMAR, increasing distance between the sets of eccentric circles to 12 cm, moving the card back and forth from 40 to 20 cm or from side to side, up and down, and in circles.

Appendix 2: Accommodation Exercises

Each exercise was performed monocularly for 3 minutes with each eye while the children wore their habitual correction, if any.

Phase 1

Distance-to-Near Accommodative Rock. Level 1

The child alternated focus between two 0.4 logMAR letters charts at 4 m and 40 cm, respectively, reading aloud the first line at the distance chart, the second on the near chart, and so on.

Level 2

After 1 week, the level of difficulty was increased by changing the letter size to 0.3 logMAR and decreasing the viewing distance of the near chart to 20 cm.

Accommodative Flippers. Level 1

The child read aloud a line of 0.4 logMAR letters at 40 cm alternately through a −1.50 D lens and a +1.50 D lens. If clarity could not be obtained, the power of the lenses was reduced in steps of 0.5 D until the child could perform the task.

Lens Rock – Varying Vertex Distance. Level 1

The child viewed a 0.4 logMAR letter chart at 4 m through a −3.00 D lens held at 30 cm vertex distance and when clarity was obtained the accommodative demand was gradually increased by slowly moving the lens toward the eye until clarity could no longer be obtained. The child then moved the lens back and forth attempting to reduce the vertex distance. The procedure was repeated while the child viewed 0.4 logMAR letters at 40 cm through a +1.00 D lens.

Level 2

After 1 week of home exercises, the level of difficulty was increased by changing the letter size to 0.3 logMAR and the lenses to −6.00 D and +2.50 D, respectively.

Phase 2

Distance-to-Near Accommodative Rock. Level 3

The procedure described for levels 1 and 2 were repeated with letter size decreased to 0.2 logMAR and near chart was held at 10 cm.

Accommodative Flippers. Level 2

The procedure described for level 1 was repeated with letter size decreased to 0.3 logMAR viewed through +/−2.00 D.

Lens Rock – Dual Focus. Level 3

The child viewed a 0.3 logMAR letter chart at 40 cm through a −3.00 D lens held so that the letter charts could be seen above and through the lens simultaneously giving rise to the sensation of one clear and one blurred image. The child obtained clarity of the letters above the lens for 5 to 10 seconds and then through the lens. The exercise was repeated with −6.00 D, +1.00 D, and +2.50 D.

Phase 3

Accommodative Flippers. Level 3

The procedure described for level 1 was repeated with letter size reduced to 0.2 logMAR viewed through +/−2.50 D.

Toric Lenses. The child was provided with 3 toric lenses with spherical powers of +2.00 D, 0.00 D, and −2.00 D in the horizontal meridian and 2.00 D lower power in the vertical meridian. While viewing a grid of 5 horizontal and 5 vertical lines at 40 cm through one of the lenses, the child was instructed to alternate between keeping the horizontal and vertical lines clear for 10 seconds.

Lens Sorting. The child was provided with 4 lenses with the power of, respectively, −2.00 D, −1.00 D, +1.00 D, and +2.00 D labeled with random letters. The child was instructed to look at 0.2 logMAR letters at 40 cm through each of the lenses, obtain clarity, and to sort the lenses from weakest to strongest.

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