0093-7002/87/6406-0411$02.00/0
AMERICAN JOURNAL OF OPTOMETRY & PHYSIOLOGICAL OPTICS

Vol. 64, No. 6, pp. 411–414
Printed in U.S.A.

symposium paper

Efficacy of Vision Therapy for Nonstrabismic Vergence Anomalies

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ABSTRACT

A review of the literature published in the past 15 years was carried out to determine the effect of visual training on vergence measurements for nonstrabismic patients. Results of cited studies are summarized.

Key Words: convergence insufficiency, vergences, symptoms, visual training effects

Practitioners generally agree that vergence ranges can be improved as a result of training. This was implied in a position statement on vision therapy by the American Optometric Association.[1] However, there were only three references cited that pertain to the effectiveness of training on vergences. This paucity of proof is reminiscent of my experience when the question is asked, "Where are your statistics showing that vision therapy works?"

METHODS

For the sake of brevity, my survey was directed to two questions: (1) Were the objective findings of vergence measurements increased? (2) Were subjective visual problems abated as a result of vision therapy? I limited my investigation to horizontal vergences. No studies involving subjects who had amblyopia, strabismus, or ocular disease were cited. Furthermore, only convergent and divergent fusional (disparity) vergences were considered; accommodative, proximal, and tonic vergences are omitted from this discussion.

I requested a computerized Medline Search going back 15 years.[2] Only two additional studies were found. Meticulous reviewing of the literature became necessary. I attempted an extensive, but not exhaustive, search in texts on the topic and in pertinent articles in refereed journals. I also reviewed some of the verifiable research projects in which I was involved personally.

RESULTS

Griffin[3] stated, "The . . . component . . trainable . . . is fusional (disparity) vergence. The greatest changes are in positive fusional vergence." Borish[4] reported, ". . . range of relative convergence may be varied by training, particularly on the positive end (base-out)." Grisham[5] expressed, "Fusional vergence is a readily trainable visual skill." Although clinical opinion holds that fusional vergence can be improved with training, experimental studies are needed to validate this view.

Griffin et al.[6] conducted an experiment on nearpoint vergences with 9 asymptomatic exophoric young adults and a control group of 7 subjects. Six 15-min training periods of automated push-up exercises over a 2-week period resulted in significant changes in fusional convergence ranges and better nearpoint of convergence. Before training the nearpoint base-out (BO) break was 26$^{\Delta}$, and after training it was 34$^{\Delta}$. The near exophoria decreased from a mean of 8$^{\Delta}$ to 2$^{\Delta}$. Prism (vergence) adaptation seemed to have occurred.

This paper is based on an oral presentation given by Dr. Griffin on December 10, 1985 at the Symposium on Management of Binocular Anomalies: Efficacy of Vision Therapy. This meeting was sponsored by the Binocular Vision and Perception Section at the Annual Meeting of the American Academy of Optometry in Atlanta, Georgia.

Received January 5, 1987.

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Farpoint vergences were studied by Griffin et al.[7] on 30 asymptomatic young adult subjects, 10 in the control group, 10 in a standard training regimen, and 10 using the Cine-Ortho method. Most of the stimuli were slow moving and sliding (tonic) vergence demands. No subjects had symptoms or had prior vergence training. Treatment time was 45 min for 3 sessions over a period not to exceed 5 weeks. Mean differences between pre- and post-testing are shown in Table 1. Note that base-in (BI) (divergence) ranges did not improve significantly, but the BO (convergence) ranges did improve, except for BO to blur with the Cine-Ortho method.

Major et al.[8] used a tonic vergence method similar to the Cine-Ortho but on a computer video display terminal at near. They pre- and post-tested nearpoint vergence ranges on 39 young adult subjects; 13 in the control group, 13 in a standard training regimen and 13 in the computerized program. Results are shown in Table 2. The important point here is that the computerized regimen resulted in significant improvement in BI blur and break ranges. Table 3 indicates there was an increase in the amplitude for blur and break. This implies that any prism adaptation was bidirectional (not just BI) because both BO and BI ranges were increased. These amplitudes showed no decrease after 65 days in a random sample of 6 of the 13 subjects who were trained with the computerized regimen. Vision therapy appears to have had a lasting effect.

Goodson and Rahe[9] provided vergence training to Air Force pilots, eight in the experimental group and six in the control group. Treatment time was for nine 1-h visits during a 2-week period. The only significant change was in BO to blur. Conventional therapy, therefore, did not result in increased BI ranges at far.

Daum[10] provided training for 35 asymptomatic young adults. Treatment time was 10 min daily for 3 weeks, consisting mostly of home training. BO blur, break, and recovery "increased substantially" at far and near. BI ranges "... did not show substantial increases ... This may be a result of an innate resistance to change ... may reflect a need for a longer period of training ... or the need for using other techniques...." A subsample was retested 21 weeks after treatment was completed. There was some decrease in ranges, but the training effect remained.

Taking another approach to therapy, Vaegan[11] used extreme prism demands for durations of 5 min. This isometric method of treatment resulted in increased BI and BO ranges, both immediately and for a delayed time period. It appears that prism adaptation was taking place in both directions for these subjects.

TABLE 1. Mean increases in prism diopters between pre- and post-testing (Griffin et al.[7]).

	Standard Therapy (Δ)	Cine-Ortho Therapy (Δ)
BI break	0.60	1.50
BI recovery	0.10	1.00
BO blur	8.25[a]	3.33
BO break	0.90[a]	8.80[a]
BO recovery	7.30[a]	6.40[a]

[a] Significant difference ($p < 0.05$) between this and control group.

TABLE 2. Mean increases in prism diopters between pre- and post-testing (Major et al.[8]).

	Standard Therapy (Δ)	Computerized Therapy (Δ)
BI blur	1.64	5.46[a]
BI break	0.08	3.44[b]
BI recovery	0.95	1.28
BO blur	9.77[b]	8.00
BO break	10.23[b]	8.72
BO recovery	7.42	6.05

[a] Significant difference between this and control group ($p < 0.01$).

[b] Significant difference between this and control group ($p < 0.05$).

TABLE 3. Significant difference between the control group in vergence amplitude (total BI-BO range) at the 0.05 level (Major et al.[8]).

	Standard Therapy	Computerized Therapy
Blur	No	Yes
Break	Yes	Yes
Recovery	No	No

Cooper and Feldman[12] effectively improved BO ranges at near by using random dot stereograms with changing vergence demands along with operant conditioning procedures. How much effect the operant conditioning had in relation to this novel use of random dot stereograms is not known. I believe operant conditioning with positive reinforcement for subjects is recommended in all vision therapy cases.

Henson and North[13] investigated prism adaptation effects on normal subjects wearing 6Δ BO for 3.5 min. The immediately induced phoria decreased by a mean of 3.9Δ, which indicated a substantial vergence adaptation to the prism demand.

Daum[14] studied the effect of smooth, slow, tonic vergence training vs. quick, stepwise, phasic training on 34 asymptomatic young adults. Treatment time was 10 min per day each

weekday for 3 weeks. Group 1 consisted of 17 subjects who received tonic training via sliding vergences; group 2 consisted of 17 subjects who received phasic training via stepping vergences. Results are shown in Table 4. Vergences were enlarged more in group 2 than in group 1. According to Daum, "... there are many possible deficiencies of the fusional vergence system including but not limited to the amplitude of the response which is the classical technique for measuring fusional vergence capability." and "There are differences in the efficiency of the techniques used for training of the vergence system...."

Hoffman et al.[15] studied the effect of therapy on convergence insufficiency patients. Treatment time was 45 min, twice a week for 25 visits. The success rate was 88% using the criterion of BO to blur being 3 times the magnitude of the exophoria.

The previous studies did not address directly the question of subjective visual problems being abated as a result of vision therapy. However, the following studies pertain to symptoms. Camuccio and Griffin[16] reported the subjective complaints of an 18-year-old female who had convergence insufficiency and whose symptoms were abated. Results of vergence improvements are shown in Table 5. Before therapy the BI recovery at near was deficient, as were the BO to blur and break ranges at far. Normal ranges resulted after five therapy visits.

TABLE 4. Mean increases in farpoint vergences in prism diopters between pre- and post-testing: group 1, tonic training; group 2, phasic training (Daum[14]).

	Group 1 (Δ)	Group 2 (Δ)
BI break	1.88[a]	2.41[a]
BI recovery	0.88	2.23[a]
BO blur	3.29[a]	7.64[a]
BO break	8.41[a]	13.29[a]
BO recovery	7.64	14.06[a]

[a] Significant difference (t-test, $p < 0.05$) between training and control periods.

TABLE 5. Increases in ranges in prism diopters of a subject who had vergence training (Camuccio and Griffin[16]).

	Before (Δ)	Norm	After (Δ)
BI recovery at near	4[a]	14	18
BO blur at far	4[a]	12	14
BO break at far	9[a]	20	24

[a] Lower (by more than 1 SD) than the norms of Griffin and Lee.[17]

Dalziel[18] reported on 100 convergence insufficiency subjects who failed to meet Sheard's criterion at near. Therapy consisted of two office visits for 45 min and home training over an average of 6 weeks' duration. Before therapy 83% had symptoms, and only 7% had symptoms after vision therapy. Vergence ranges were improved in most cases, and all but 16 passed Sheard's criterion after therapy.

Wick[19] treated 134 symptomatic presbyopic subjects who had convergence insufficiency, exo at near exceeding 14Δ. Treatment time was 30 min per day of home training for about 10 weeks with biweekly office visits. Only 4 subjects had symptoms after vision therapy. In general the training resulted in changed slopes of forced fixation disparity curves from steep to flat. Flattened slopes were related to success of improved vergence ranges and to the abatement of symptoms. Most authorities concur that the slope of the forced fixation curve is associated with symptoms. Teitelbaum et al.,[20] on the other hand, reported no significant difference between symptomatic and asymptomatic subjects in a different study.

Kertesz[21] studied the effects of training on 13 symptomatic subjects, ages 9 to 53 years, who had convergence insufficiency. Large complex targets (e.g., random dot patterns) were moved slowly. Treatment time was 30 min, once a week, for an unspecified number of weeks. There was an enlargement of BO break and recovery ranges and abatement of symptoms in 11 subjects. Retesting 2.5 years later showed lasting results.

North and Henson[22] studied prism adaptation ability in 7 subjects who had convergence insufficiency and symptoms. Prism adaptation ability was achieved after vision therapy, and abatement of symptoms was associated with acquirement of adaptation. They contended that compensating prisms may be necessary if symptoms remain and there is no adaptation ability after vision therapy.

DISCUSSION

There is little doubt that vision therapy can enlarge fusional convergence ranges in most cases. BO ranges at near and far were shown to increase in every reference I could find and cite on this subject. The effect of prism adaptation[23] on meeting BO demands is evident in the studies of Griffin et al.,[6] Henson and North,[13] and North and Hensen.[22]

However, success in fusional divergence therapy is questionable from the results of Griffin et al.,[7] Goodson and Rahe,[9] and Daum,[10] although subjects in these studies were asymptomatic young adults who presumably had adequate BI ranges initially. It can be speculated

that less change in BI range can be expected after training in normal subjects than in those who have deficient BI ranges before training.

Although Daum[10] found no significant BI range increase, a similar later study of Daum[14] did show significant improvement in most of the BI ranges. The increases were greater for phasic than for tonic training procedures. However, Vaegan[11] found isometric training to be an effective BI training procedure. It is possible that the improved BI ranges found by Major et al.[8] involved both tonic training with using slowly moving computerized targets on the video display terminal and isometric prism adaptation effects as a result of sustained extreme prism demands. The motivational effects of the computerized procedure were similar to operant conditioning and cannot be discounted in making tonic and isometric training successful.

Until further research provides more detailed factor analysis to indicate whether phasic, tonic, or isometric is the most effective method in a particular case, I recommend procedures with large complex targets and computerized programs using all three methods.

Subjective visual problems were abated in all studies cited, although these only dealt with cases of convergence insufficiency. Further research is needed to verify the efficacy of vision therapy in relieving symptoms in convergence excess and other vergence anomalies.

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