5-1991

Optometric extension program: 1991 bibliography of near lenses and vision training research

Dawn L. Werner
Pacific University

Susan M. Glad
Pacific University

Kevin B. Biegel
Pacific University

Lorene V.K. Chai
Pacific University

Optometric extension program: 1991 bibliography of near lenses and vision training research

Abstract

Optometric extension program: 1991 bibliography of near lenses and vision training research

Degree Type

Thesis

Degree Name

Master of Science in Vision Science

Committee Chair

Paul Kohl

Second Advisor

William Ludlam

Subject Categories

Optometry

OPTOMETRIC EXTENSION PROGRAM

1991
BIBLIOGRAPHY OF NEAR LENSES AND VISION TRAINING RESEARCH

by

Dawn L. Werner
Susan M. Glad
Kevin B. Biegel
Lorene V. K. Chai

A Thesis presented to the faculty of the

Pacific University
College of Optometry
Forest Grove, Oregon

for the degree of

Doctor of Optometry

May, 1991

Advisors:
Paul Kohl, O.D.
William Ludlam, O.D.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

We would like to express our gratitude to our advisors, Paul Kohl, O.D. and William Ludlam, O.D., and Thesis Coordinator Robert Yolton, O.D. for their patience in waiting for this project to be completed. A special thank-you is extended to both Dean Richard Reincke, O.D. and Leonard Levine, Ph.D. for their assistance in helping us become more computer literate and for making it possible to access a database via computer communications systems. We expecially appreciate the patience and understanding shown to us by our friends and families as they endured our moods and long absenses while this project was being compiled.

FORWARD

It was our intention to make this a most complete and accurate bibliography. However, misspellings and ommissions are a possibility in any paper. We apologize in advance to any author whose name may have been misspelled, article title miskeyed, or who has contributed pertinent work that we may have inadvertently failed to include in our bibliography.

NEARPOINT LENSES

Birnbaum MH
"Management of the low myopia pediatric patient." *J Am Optom Assoc* 1979 Nov;**50**(11):1281-9

A review of the literature on myopia etiology indicates that environmental factors, particularly those related to nearpoint use of the eyes, appear to play a significant role. A regimen is described for control of environmental factors producing myopic progression, including use of bifocal lenses to reduce accomodative demand, visual hygiene to foster accommodative relaxation, and vision training to develop adequate accommodative skills and freedom of action between accommodative and convergence systems.

Birnbaum MH
"Nearpoint visual stress:a physiological model." *J Am Optom Assoc* 1984 Nov; **55**(11):825-35

The nearpoint visual stress theory holds that a tendency for conver-gence to localize closer than accommodation is intrinsic to the nearpoint visual demands imposed by our culture. A physiological model is presented, suggesting that this effector system mismatch arises from the activation of autonomic reflexes related to stress, vigilant attention and information processing. Autonomic arousal exerts a cycloplegic-like effect. Excess accommodative effort, which must be exerted to achieve required accommodation, produces a tendency towards overconvergence. The demand for integration of accommodation and convergence, essential for efficient nearpoint function, is thus incompatible with our own physiology, since autonomic arousal is inherent in task demands for attention and mental effort associated with reading. Additionally, autonomic arousal is generated by the high levels of stress pervasive in our society. Various refractive, binocular and accommodative deviations may arise adaptively in order to resolve this mismatch and facilitate efficient nearpoint visual function. These nearpoint stress-induced visual disorders parallel stress-induced systemic illness in that both result from the activation of physiological processes which are inappropriate for the demands and stresses of our society.

Birnbaum MH
"Nearpoint visual stress:clinical implications." *J Am Optom Assoc* 1985 Jun; **56**(6):480-90

A physiological model of nearpoint stress, based on autonomic arousal, was presented in a companion paper. This paper deals with clinical implications of the nearpoint stress model, including clinical manifestations, adaptive responses to nearpoint stress, and management of nearpoint stress-induced vision disorders.

Birnbaum MH
"Symposium on nearpoint visual stress-Introduction." *Am J Optom Physiol Opt* 1985 Jun;**62**(6):361-4

Chase SR Edmunds FM
"Plus lenses used in prepresbyopia for the control of myopia." Optometric Extension Program 1981 Aug;**53**(11):1

Getman GN
"Unique lenses in school vision programs." *Research Reports and Special Articles*, Optometric Extension Program, 1983 Mar;**55**(6):47

Goss DA
"Overcorrection as a means of slowing myopic progression." *Am J Optom Physiol Opt* 1984 Feb;**61**(2):85-93

Thirty-six subjects (18 males and 18 females) ranging in ages from 7.38 to 15.82 years received an overcorrection of 0.75 D over the power required to correct their myopia exactly. These 36 experimental subjects were matched by control subjects selected at random from the files of the Indiana University Optometry Clinics. The criteria used in matching were sex, beginning age, beginning refractive error, and duration of time covered by the record. The mean rate of change of refractive error for the experimental group was (minus indicating increase of myopia) -0.49 D/year (range, +0.37 to -1.95 D/year) on retinoscopy and -0.52 D/year (range, +0.21 to -1.32 D/year) on subjective refraction. The mean rate of change for the control group was -0.47 D/year (range, +0.06 to -2.03 D/year) on retinoscopy and -0.47 D/year (range, +0.28 to -1.72 D/year) on subjective refraction. Rates for the experimental and control groups were not significantly different. The results of this study do not support the hypothesis that an overcorrected myope has a lower rate of increase of myopia than a myope wearing a conventional spectacle correction.

Greenspan SB
"Behavioral effects of children's nearpoint lenses." *J Am Optom Assoc* 1975 Oct;**46**(10):1031-7

Greenspan SB
"Effects of children's nearpoint lenses upon body posture and performance." *Am J Optom Arch Am Acad Optom* 1970 Dec;**47**(12):982-9

Statistically significant behavorial changes occured among seven of 11 subjects, including increases in nearpoint working distance and in performance on a pencil-and-paper task.

Greenspan SB
"A study of nearpoint lenses: effects on body posture and performance." *Research Reports and Special Articles*, Optometric Extension Program 1975 May

Grosvenor T Goss DA
"The role of bifocal and contact lenses in myopia control." *Acta Ophthal Suppl* (Copenh) 1988;**185**:162-6

This manuscript reviews the recent work on the use of bifocal spectacles and 'hard' contact lenses for the control of myopia, with emphasis on the studies conducted by the authors.

Gruning CF
"Clinical management of nearpoint stress-induced vision problems." *Am J Optom Physiol Opt* 1985 Jun;**62**(6):386-91

Functional vision problems caused by or associated with nearpoint vision stress include: accommodative disorders (insufficiency, ill-sustained, infacility); abnormal heterophorias (esophoria, high exophoria); and vergence disorders. These vision disorders cause problems with acuity, comfort, and performance (efficiency). A combination of lens prescribing, vision therapy, and work/study visual hygiene recommendations can eliminate or greatly reduce nearpoint stress-induced vision problems.

Hittner HM Chokshi DB
"Results of treatment in unilateral high myopia with amblyopia." *Am Orthopt J* 1978;**28**:74-7

Hittner HM Chokshi DB
"Results of treatment in unilateral high myopia with amblyopia." *Am Orthopt J* 1978;**28**:74-7

Horner SH
"Use of lenses & prisms to enhance visual training." Optometric Extension Program, Oct 1972-Sep 1973;**45**(1-12)

Jacob JL Beaulieu Y Brunet E
"Progressive-addition lenses in the management of esotropia with a high accommodation/convergence ratio." *Can J Ophthal* 1980 Oct;**15**(4):166-9

In 25 children esotropia due to abnormal synkinesis between accommodation and accommodative convergence was corrected with progressive-addition lenses. Twelve of the children had been wearing conventional bifocals; the other 13 were given progressive lenses for the first time. The near esodeviation was satisfactorily neutralized in most cases, and nearly all the children had some stereopsis. All adapted well and without difficulty to the progressive lenses.

Liberman J
"Prescribing for performance and prevention." *J Am Optom Assoc* 1976 Aug; **47**(8):1058-64

Ludwig IH Parks MM Getson PR
"Long-term results of bifocal therapy for accommodative esotropia." *J Ped Ophthal Strab* 1989 Nov-Dec;**26**(6):264-70

We studied the long-term course of 65 accommodative esotropes who required bifocals to maintain alignment at near. Average followup was 10.5 years. Forty patients (61.5%, group DC [bifocals discontinued]) were able to discontinue bifocal use after an average of 5.5 years wear. Twenty-five (38.5%) continued to wear bifocals (or a suitable alternative such as reading glasses), after an average 9.7 years of followup. Surgical correction of deteriorated accommodative esotropia was performed for 20 patients (50%) in group DC, and nine (36%) of those in group C[bifocals continued]. Surgery produced an average reduction in the accommodative convergence relationship (near esodeviation in prism diopters [pd] minus corrected distance measurement, AC/A) of approximately 10 pd in both groups. Surgical patients unable to discontinue bifocal wear began with a clinically higher AC/A than those in group DC. Nonsurgical patients in group DC experienced spontaneous improvement of the AC/A over time (average, 6.2 pd). On average, this did not occur in those of group C. Average age of bifocal discontinuation was 9.7 years in surgical patients and 9.3 years in the nonsurgical. Surgical patients had significantly lower hyperopia (+2.4 diopters [D]), than nonsurgical (+3.5 D), and an earlier age of onset of bifocal wear (3.29 versus 4.64 years). Although bifocals may be successfully discontinued in a majority of patients at an average age of 9.5 years, a significant percentage require long-term wear, some, despite surgery. The only factor that predicted long-term bifocal wear was a relatively high AC/A.

Manor RS
"Use of special glasses in treatment of spasm of near reflex." *Ann Ophthal* 1979;**11**:903-908

Spasm of near reflex manifests itself in attacks of convergence, accommodation and miosis. It is frequently misdiagnosed as bilateral sixth nerve palsy. In many instances treatment of the accommodative element of the spasm of near reflex does not give a prompt result and thus fails to dissipate the suspicion of the neurosurgeon concerning the presence of "abducens palsy." One patient having spasm of near reflex was given eyeglasses in which the inner third of each lens had been made opaque. It

was rationalized that the patient would be forced to choose one of two alternatives: a continuation of the spasm of near reflex and see nothing (in convergence both eyes being blocked by the opaque glass), or interruption of the spasm of convergence with straightening of the eyes and to be able to see through the transparent middle part of the eyeglasses. In this patient there was an immediate straightening of the eyes with a concommitant disappearance of the headaches and diplopia. The good results obtained in this patient would seem to justify additional trials in using eyeglasses with an opaque inner third of each lens in similar patients.

Mohindra I Molinari J
"Convergence insufficiency: its diagnosis and management - part 3." *Opt Mthy* 1980;**71**(5):310-3.

The management of fusional and accommodative facilities beyond near distances and of relative convergence is discussed as well as surgery and base-in prism prescriptions.

Oakley KH Young FA
"Bifocal control of myopia." *Am J Optom Physiol Opt* 1975 Nov;**52**(11):758-64

Forty-three native American bifocal wearers grouped by yearly age levels from 9 to 15 with a mixed group of 6 to 8 year olds are matched on beginning age, sex, beginning refractive error and ending age with 83 Native American control subjects. Similarly 226 Caucasian bifocal wearers are matched on the same criteria against 192 control subjects. Although the comparisons are made on each age group, the average annual rate of progression for the bifocal Native American subjects is -0.12 and -0.10 diopters in the right and left eyes respectively against a comparable rate of progression of -0.38 and -0.36 diopters for the control subjects. These differences are significant but not as significant as those found on the Causcasian subjects of -0.02 and -0.03 diopters right and left eyes against -0.53 and -0.52 diopters for the controls.

Parssinen O Hemminki E
"Spectacle-use, bifocals and prevention of myopic progression. The two-years results of a randomized trial among schoolchildren." *Acta Ophthal Suppl* (Copenh) 1988;**185**:156-61

This paper gives the two-year followup results of a randomized trial of three different types of corrective lenses: 1) minus lenses with full correction for continuous use (the Reference group); 2) minus lenses with full correction to be used for distant vision only; and 3) bifocal lenses. A total of 240 9-11-years old mildly myopic schoolchildren were randomly allocated to the three different treatment groups to be followed up for 3 years. After 2-years follow-up the change in the spherical equivalent was greatest in the distant use group. There were no significant positive correlations between changes in refraction and accommodation or refraction and convergence.

Pierce JR
"Research on the relationship between nearpoint lenses, human performance, and physiological activity of the body." *Research Reports and Special Articles*, Optometric Extension Program Oct 1966-Sep 1976; 39(1-12)

Pierce JR
"Studies of individual behavior as a function of a complete range of nearpoint lenses." *Research Reports and Special Articles*, Optometric Extension Program Oct 1967-Feb 1968;**40**:(1-5)

Pratt-Johnson JA Tillson G
"The management of esotropia with high AC/A ratio (convergence excess)." *J Ped Ophthal Strab* 1985 Nov-Dec;**22**(6):238-42

This paper reviews the long-term followup of esotropia with a high AC/A ratio defined as an increase of 20 delta or more of the esotropia at near compared with distance with the full optical correction of any refractive error in place. Ninety-nine patients were studied for an average followup of eight years. Eighty-six achieved fusion but only five achieved central fusion. Forty-five were treated with bifocals. No significant difference in the sensory results were recorded in those patients wearing bifocals compared with those who did not wear bifocals. No patient had miotic therapy for more than a few months. The suppression characteristic of this condition is reviewed.

Roberts WL Banford R
"Evaluation of bifocal correction techniques in juvenile myopia." *Optom Wkly* 1967 Sept 21,28; Oct 5,12,26

Rutstein RP Marsh-Tootle W London R
"Changes in refractive error for exotropes treated with overminus lenses." *Optom Vis Sci* 1989 Aug;**66**(8):487-91

The refractive changes of pediatric patients who were prescribed overminus lenses for exotropia were evaluated. Overminus lenses means additional minus power over the lenses required to correct the refractive error at distance. Forty exotropic patients, ages 1 to 15 years, were prescribed overminus lenses (-0.50 D to -3.75 D) for a period of 9 to 86 months. A small but significant correlation was found between the initial refractive error and the mean annual change toward myopia. Other factors such as age when treat-ment was given, duration of therapy, amount of overminus, and the amount of the exodeviation had little effect on the rate of myopic change. The mean annual changes in refractive error for hyperopes (-0.13 +/- 0.44 D, N = 15), emmetropes (-0.26 +/- 0.37 D, N = 17), and myopes (-0.75 +/-0.77 D, N = 18) were similar to values reported in the literature for nonexotropic children.

Shotwell AJ
"Plus lens, prism, and bifocal effects on myopia progression in military students - Part II." *Am J Optom Physiol Opt* 1984 Feb;**61**(2):112-7

Military academies routinely lose a percentage of their pilot-qualified students to myopia during the 4-year academic program. This study investigated the progression of myopia during such a program and evaluated the usefulness of reading glasses to prevent myopia progression and subsequent acuity loss. A group of students at the United States Naval Academy comprised three randomly divided groups: a placebo group (no. 1 pink tint), a plus with prism group (+1.25 D with 2 delta base-in each eye), and a bifocal group (+1.50 D near addition). All the lens powers were relative to the experimental subject's distance refraction and were for use fulltime when reading. The pre- and post-test refractive errors at distance were determined using 1% tropicamide HCl. At the end of 4 years, the tropicamide refraction showed approximately -0.25 D of myopic shift in all groups. There were no significant differences between the myopic shifts in the controls and experimental groups.

Smith JB
"Progressive-addition lenses in the treatment of accommodative esotropia." *Am J Ophthal* 1985 Jan;**99**(1):56-62

Thirty-two children ranging in age from 18 months to 16 years were treated for accommodative esotropia with variable-focus lenses instead of executive bifocals. The major advantages were the improved appearance of the glasses and the more natural progression of accommodative treatment from distance to near which provided more relaxation of convergence in theintermediate zone. The chief disadvantage was the difficulty fitting small children with lenses that were originally designed for the use of presbyopic adults. The maximum power for the effective control of the deviation for reading is at the bottom of the lens. Keeping this portion of the lens high enough proved to be difficult in small children. None of the patients were willing to return to executive bifocals after having worn progressive-addition lenses.

Smith JB
"Treatment of esotropia with progressive-addition lenses." *Am Orthopt J* 1986;**36**:127-130

For the past three years, progressive-addition lenses have been successfully prescribed as a substitute for executive bifocals and cholinesterase inhibitors in the treatment of accommodative esotropia. The use of these "invisible bifocals" was originally designed to improve the appearance of the glasses, but the lenses have also provided more secure control of the deviation in the intermediate distance. In addition, maximum accommodative treatment can be given a patient without fusion to obtain a cosmetically acceptable angle of deviation distance and near without the stigma of bifocals.

Spafford MM
"Modification of cortical activity by low plus lenses." *Am J Optom Physiol Opt* 1983 Jun;**60**(6):535-37

Sullivan JB Ritzinger ML
"The long term effects of the MEM lens on performance." *Research Reports & Special Articles*,Optometric Extension Program 1978 Jun;**50**(9):1

Viikari K
"Minus or plus lenses in the therapy of the convergence spasm?" [letter] *J Clin Neuro Ophthal* 1984 Mar;**4**(1):71-2

von Noorden GK Morris J Edelman P
"Efficacy of bifocals in the treatment of accommodative esotropia." *Am J Ophthal* 1978 Jun;**85**(6):830-4

We treated 84 patients with a partially refractive accommodative esotropia with bifocals. Twelve patients were able to fuse without bifocals at the end of therapy; in 19, the bifocal power could be reduced and further improvement can be expected in the future. Thirty-nine remained dependent on bifocals; and in 14, fusion had deteriorated in spite of therapy. Patients with a high AC/A ratio and those receiving supportive orthoptic treatment seemed to fare best with bifocals. In those with a low AC/A ratio, fusion tended to deteriorate because of a slowly increasing esodeviation at near fixation.

Wildsoet CF Foo KH
"Reading performance and low plus lenses." *Clin Exper Optom* 1988 May;71(3):100-5

Low plus lenses are used extensively by functional optometrists to treat near point stress and associated reading problems. However there have been few attempts to quantify the effects of these lenses on performance in con-

trolled experiments. In the current study, reading performance of 13 children who had been wearing low plus lenses was assessed with a Biometric Eye-Trac Recorder through both plano lenses and lenses matching the children's prescriptions. All children had worn their low plus prescriptions for between six and 15 months. We found no statistically significant difference in reading performance measured through the low plus lenses and plano lenses, for the four parameters examined ie. reading speed, frequencies of fixations and regressions, and comprehension. A number of alternative explanations for these results are explored, including the possibility of a positive placebo effect.

Zhong RX Shi RR Huang LX et al
"Prevention and treatment of youth myopia by binocular near fogging."
Chin Med J [Engl] 1983 Jun;**96**(6):457-62

MYOPIA CONTROL
NEAR POINT LENSES

Birnbaum MH
"Management of the low myopia pediatric patient." *J Am Optom Assoc* 1979 Nov;**50**(11):1281-9

A review of the literature on myopia etiology indicates that environmental factors, particularly those related to near-point use of the eyes, appear to play a significant role. A regimen is described for control of environmental factors producing myopic progression, including use of bifocal lenses to reduce accomodative demand, visual hygiene to foster accommodative relaxation, and vision training to develop adequate accommodative skills and freedom of action between accommodative and convergence systems.

Chase SR Edmunds FM
"Plus lenses used in prepresbyopia for the control of myopia." Optometric Extension Program 1981 Aug;**53**(11):1

Goss DA
"Overcorrection as a means of slowing myopic progression." *Am J Optom Physiol Opt* 1984 Feb;**61**(2):85-93

Thirty-six subjects (18 males and 18 females) ranging in ages from 7.38 to 15.82 years received an overcorrection of 0.75 D over the power required to correct their myopia exactly. These 36 experimental subjects were matched by control subjects selected at random from the files of the Indiana University Optometry Clinics. The criteria used in matching were sex, beginning age, beginning refractive error, and duration of time covered by the record. The mean rate of change of refractive error for the experimental group was (minus indicating increase of myopia) -0.49 D/year (range, +0.37 to -1.95 D/year) on retinoscopy and -0.52 D/year (range, +0.21 to -1.32 D/year) on subjective refraction. The mean rate of change for the control group was -0.47 D/year (range, +0.06 to -2.03 D/year) on retinoscopy and -0.47 D/year (range, +0.28 to -1.72 D/year) on subjective refraction. Rates for the experimental and control groups were not significantly different. The results of this study do not support the hypothesis that an overcorrected myope has a lower rate of increase of myopia than a myope wearing a conventional spectacle correction.

Grosvenor T Goss DA
"The role of bifocal and contact lenses in myopia control." *Acta Ophthal Suppl* (Copenh) 1988;**185**:162-6

This manuscript reviews the recent work on the use of bifocal spectacles and 'hard' contact lenses for the control of myopia, with emphasis on the studies conducted by the authors.

Hittner HM Chokshi DB
"Results of treatment in unilateral high myopia with amblyopia." *Am Orthopt J* 1978;**28**:74-7

Liberman J
"Prescribing for performance and prevention." *J Am Optom Assoc* 1976 Aug;**47**(8):1058-64

Oakley KH Young FA
"Bifocal control of myopia." *Am J Optom Physiol Opt* 1975 Nov;**52**(11):758-64

Forty-three native American bifocal wearers grouped by yearly age levels from 9 to 15 with a mixed group of 6 to 8 year olds are matched on beginning age, sex, beginning refractive error and ending age with 83 Native American control subjects. Similarly 226 Caucasian bifocal wearers are matched on the same criteria against 192 control subjects. Although the comparisons are made on each age group, the average annual rate of progression for the bifocal Native American subjects is -0.12 and -0.10 diopters in the right and left eyes respectively against a comparable rate of progression of -0.38 and -0.36 diopters for the control subjects. These differences are significant but not as significant as those found on the Causcasian subjects of -0.02 and -0.03 diopters right and left eyes against -0.53 and -0.52 diopters for the controls.

Parssinen O Hemminki E
"Spectacle-use, bifocals and prevention of myopic progression. The two-years results of a randomized trial among schoolchildren." *Acta Ophthal Suppl* (Copenh) 1988;**185**:156-61

This paper gives the two-year followup results of a randomized trial of three different types of corrective lenses: 1) minus lenses with full correction for continuous use (the Reference group); 2) minus lenses with full correction to be used for distant vision only; and 3) bifocal lenses. A total of 240 9-11-years old mildly myopic schoolchildren were randomly allocated to the three different treatment groups to be followed up for 3 years. After 2-years follow-up the change in the spherical equivalent was greatest in the distant use group. There were no significant positive correlations between changes in refraction and accommodation or refraction and convergence.

Roberts WL Banford R
"Evaluation of bifocal correction techniques in juvenile myopia." *Optom Wkly* 1967 Sept 21,28; Oct 5,12,26

Shotwell AJ
"Plus lens, prism, and bifocal effects on myopia progression in military students - Part II." *Am J Optom Physiol Opt* 1984 Feb;**61**(2):112-7

Military academies routinely lose a percentage of their pilot-qualified students to myopia during the 4-year academic program. This study investigated the progression of myopia during such a program and evaluated the usefulness of reading glasses to prevent myopia progression and subsequent acuity loss. A group of students at the United States Naval Academy comprised three randomly divided groups: a placebo group (no. 1 pink tint), a plus with prism group (+1.25 D with 2 delta base-in each eye), and a bifocal group (+1.50 D near addition). All the lens powers were relative to the experi-mental subject's distance refraction and were for use fulltime when reading. The pre- and post-test refractive errors at distance were determined using 1% tropicamide HCl. At the end of 4 years, the tropicamide refraction showed approximately -0.25 D of myopic shift in all groups. There were no significant differences between the myopic shifts in the controls and experimental groups.

Zhong RX Shi RR Huang LX et al
"Prevention and treatment of youth myopia by binocular near fogging." *Chin Med J* [Engl] 1983 Jun;**96**(6):457-62

VISION TRAINING-GENERAL

Allard RE
"Binocular vision skills, assessment and therapy." *S Afr Optom* 1988 Jun;**47**(2):17

Amigo G
"Present trends in orthoptics and pleoptics in Giessen." *Am J Optom Arch Am Acad Optom* 1970 Sep;**47**(9):709-14

Appler DV Quimby CA
"The effect of ambient room illumination upon Wayne Saccadic Fixator performance." *J Am Optom Assoc* 1984 Nov;**55**(11):818-21

> This paper begins to establish age/grade norms for primary school children using the Wayne Saccadic Fixator. Samplings from three separate school systems provide the data base. Performance strategies are discussed. The norms that are presented vary significantly depending upon the ambient room illumination. This bespeaks the need for more thorough documentation when publishing data derived from the Wayne Saccadic Fixator.

Bachara GH Zaba JN
"Psychological effects of visual training." *Acad Therapy* 1976 Fall:99-104

Bartlett JD
"Political attacks on vision therapy." [editoria] *J Am Optom Assoc* 1987 Jul;**58**(7):534

Baxtrom CR
"Resources for vision therapy equipment." Optometric Extension Program 1987 Mar;**59**(6):309

Beauchamp GR
"Optometric vision training." *Pediatrics* 1986 Jan;**77**(1):121-4

Bell BRK
"Vision training for service and profit." *Optom Man* 1982 Aug;**18**(8):27-35

Bierman A
"Vision therapy." [letter] *J Am Optom Assoc* 1988 Feb;**59**(2):86-7

Birnbaum MH
"Holistic aspects of visual style: a hemispheric model with implications for vision therapy." *J Am Optom Assoc* 1978 Oct;**49**(10):1133-41

> A model is proposed relating styles of cognition and perception, modes of consciousness, and cerebral hemispheric function to visual styles and visual problems. The implications of such a model for management of vision problems are discussed. It is recommended that training for the central, eso patient emphasize procedures which are spatial, holistic, peripheral, simultaneous, and involve the use of imagery. For the peripheral, exo patient, treatment techniques should involve sequence and rhythm, analytical processing, discrimination of fine differences, and attention to detail in central areas of the visual field.

Birnbaum MH
"Perspectives on the contributions of Frederick Brock." *Am J Optom Physiol* Opt 1981 Aug;**58**(8):667-70

Birnbaum MH
"The power of visual training." *J Am Optom Assoc* 1984 Apr;**55**(4):257-60

Recent evidence suggests that the capacity to alter human function, including visual function, is substantially greater than previously thought possible. Implications of this research for the modifiability of visual function through vision therapy are discussed.

Bogdanovich G Roth N Kohl P
"Properties of anaglyphic matrials that affect the testing and training of binocular vision." *J Am Optom Assoc* 1986 Dec;**57**(12):899-903

Unequal retinal illuminances and target contrasts, and ghost images of anaglyphs can affect binocular vision. These properties were studied in red-green anaglyphic materials, and for all three pairs of red-green glasses tested, the luminoous transmittance of the green member of each pair was higher than that of the red. Differences ranged from 15.3% to 33.1%. In all combinations tested, contrast was higher with the green lens when viewing red acetate than it was for the red lens when viewing green acetate. These marked differences between red and green materials are noteworthy because they can induce differences between the two retinal illuminances, thereby affecting suppression tendencies.

Birnbaum MH
"The role of the trainer in visual training." *J Am Optom Assoc* 1977 Aug;**48**(8):1035-9

The role of the trainer in assisting the patient to internalize changes in his visual process is discussed. Emphasis is placed on two aspects: (1) making the patient aware of the nature of the change in process desired, and (2) making the patient aware that the phenomena which he observes during vision training techniques, such as blurring and clearing, diplopia, and suppression of training targets, which he may perceive as occurring esternally reflections of his visual process and as such, are subject to his control.

Burian HM
"Exodeviations: their classification, diagnosis and treatment." *Am J Ophthal* 1966 Dec;**62**(6):1161-6

Burian HM
"Orthoptics and orthoptists in 1972." *Am Orthopt J* 1973;**23**:43-7

Burian HM Franceschetti AT
"Evaluation of diagnostic methods for the classification of exodeviations." *Trans Am Ophthal Soc* 1970;**68**:56-71

Burian HM Smity DR
"Comparative measurement of exodeviations at twenty and one hundred feet." *Trans Am Ophthal Soc* 1971;**60**:188-99

Camuccio D Griffin JR
"Visual skills therapy - a case report." *Optom Mthly* 1982;**73**:94-6

A young college student with syptoms with reading, which seemed to be related to certain visual skill inefficiencies, was helped through five office visits, along with out-of-office vision therapy. All subjective and objective problems were abated with therapy.

Chase J
"Starting visual training in a busy practice." Optometric Extension Program Oct 1981 - Sep 1982;**54**(1-12)

Cohen AH
"Visual rehabilitation of a stroke patient." *J Am Optom Assoc* 1978 Jul;**49**(7):831-2

Cool SJ
"What the cat's brain tells the vision therapist's brain." Optometric Extension Program Oct 1977-Sep 1978;**1**(1)-**1**(12)

Cottle T
"Special papers (VT). Optometric Assistant Courses." Optometric Extension Program Jul 1974 - May 1976;**16**(1)-**18**(1)

Crisman MA
"Visual training: the assistant's role." Optometric Extension Program Apr 1964 - Sep 1965;**6**(1)-(6)

Dowis RT
"The effect of a visual training program on juvenile delinquency." *J Am Optom Assoc* 1977 Sep;**48**(9):1173-6

In order to demonstrate a relationship between visually related learning disabilities and juvenile deliquency, a study was conducted on institutionalized youth at Lookout Mountain School, an educational facility for committed delinquents. Complete visual testing was done, and visual therapy provided if deemed necessary. Data from the evaluations showed the most marked visual deficiencies to be in order of severity, accommodative flexibility, saccadic fixations, visual memory, No. 17B recovery, pursuits, No 16B recovery No 10 recovery. Recidivism was reduced in the group receiving visual therapy from 18% to 4%. A case study of educational and visual remediation on one student is discussed.

Dowis RT Dickerson D
"Case study--the effect of visual training program on juvenile delinquency." *J Am Optom Assoc* 1977 Sep;**48**(9):1193-4

"The efficacy of optometric vision therapy. The 1986/87 Future of Visual Development/Performance Task Force." *J Am Optom Assoc* 1988 Feb;**59**(2):95-105

Vision is not simply the ability to read a certain size letter at a distance of 20 feet. Vision is a complex and adaptable information gathering and processing system which collects, groups, analyzes, accumulates, equates, and remembers information. In this review, some of the essential components of the visual system and their disorders which can be physiologically and clinically identified, i.e., the oculomotor, the accommodative, and the fusional vergence systems have been discussed. Any dysfunctions in these systems, can lessen the quality and quantity of the initial input of information into the visual system. Deficiencies in one or more of these visual subsystems have been shown to result in symptoms, such as blurred or uncomfortable vision or headaches, or behavioral signs such as rubbing of the eyes, eyes turning inward or outward, reduced job efficiency or reading performance, or simply the avoidance of near point tasks. In addition, these signs/symptoms may contribute to reducing a person's attention and interest in near tasks. The goal of vision therapy is to eliminate visual problems, thereby reducing the frequency and severity of the patient's signs and symptoms. Vision therapy should only be expected to be of clinical benefit to patient who have detectable visual deficiencies. In response to the question, "How effective is vision therapy in remediating visual deficiencies?," it is evident from the research presented that there is sufficient scientific support for the efficacy of vision therapy in modifying and improving oculomotor, accommodative, and binocular system disorders, as measured by standardized clinical and laboratory testing methods, in the majority of patients of all ages for whom it is properly undertaken and employed. The American Optometric Asso-

ciation reaffirms its long-standing position that vision therapy is an effective therapeutic modality in the treatment of many physiological and information processing dysfunctions of the vision system. It continues to support quality optometric care, education, and research and will cooperate with all professions dedicated to providing the highest quality of life in which vision plays such an important role.

Feldman J
"Behavior modification in vision training: facilitating prerequisite behaviors and visual skills." *J Am Optom Assoc* 1981 Apr;**52**(4):329-40

Nine studies are presented illustrating how operant conditioning techniques can be used to facilitate the acquisition of task-relevant skills of young vision training patients. Four cases describe how behaviors considered prerequisite for visual skill training can be improved; task attention and motivation. Five cases show how special operant learning procedures, directly applied to visual skill performance, can facilitate the acquisition of such skills. It was suggested that all attempts at effective visual training recognize the role of scientifically based principles of learning and motivation in improving visual skills.

Ferguson SJ
"Vision therapy and binocular vision assessment." [letter] *J Am Optom Assoc* 1988 Jul;**59**(7):515

Forrest EB
"Approaching vision training." *Acad Therapy Qtly* 1968;**3**(3):151-61

Forrest EB
"Eye scan therapy for astigmatism." *J Am Optom Assoc* 1984 Dec; **55**(12):894-901

Two earlier papers introduced a new model of functional astigmatism. The investigation that led to the model indicated a relationship exists between meridional eye scanning habits and the formation of functional astigmatism. The present paper reviews the model and describes a clinical study involving the prescribing of specific eye scan therapy on a meridional basis. The results demonstrate that therapy involving eye scanning procedures has a positive effect on the control and reduction of astigmatism.

Francke AW
"Introduction to optometric visual training." Optometric Extension Program Feb 1988-Jan 1989;**60**(5)-61(4)

Friedhoffer A
"The efficacy of training."[letter] *Optom Wkly* 1974;**65**:975-6

Fukushima C
"The optometry student who needed visual training." Optometric Extension Program 1983 Aug;**55**(11):29

Getman GN
"A commentary on vision training." *J Learn Disabil* 1985 Nov;**18**(9):505-12

Goodlaw E
"Three binocularity evaluation methods." *J Am Optom Assoc* 1982 Sep;**53**(9): 707-11

Determining effort expended in binocular seeing is usually accomplished by equating dissociated phoria with total vergence ability. Fixation disparity testing by disclosing failure of precise binocular alignment is a second

method which helps to assess both direction and quantity of prism power needed to accomplish alignment. Neither of these two methods delineates the foveal role as a sensory fusional lock in binocularity. The third is the Goodlaw test in which the exact focus of the eyes is disturbed through plus and/or minus lenses, provides this information and further directs therapy.

Goodson RA Rahe AJ
"Visual training effects on normal vision." *Am J Optom Physiol* Opt 1981 Oct;**58**(10):787-91

Goodwin P
"Seeing it straight." *Nurs Times* 1990 Aug 4;**86**(35):36-8

Graybill RL
"Vision therapy in optometric practice." [letter] *J Am Optom Assoc* 1988 Oct;**59**(10):759

Groffman S
"Operant conditioning and vision training." *Am J Optom* Arch Am Acad Optom 1969 Aug;**46**(8):583-94

Hatfield C
"Visual therapy: the joy of optometry." Optometric Extension Program Oct 1976 - Sep 1977;**1**(1-12)

Heiberger MH
"The development of residency programs in vision training." *Am J Optom Arch Am Acad Optom* 1970 Nov;**47**(11):923-8

Hoffman L Cohen AH
"The developmental view of vision therapy." *J Am Optom Assoc* 1968;**39**:44-7

Hoffman L Cohen AH Feuer G
"Effectiveness of non-strabismus optometric vision training in a private practice." Am *J Optom* 1973 Oct;**50**(10):813-6

This paper reports on the rate of success of vision training on unselected non-strabismic patients in our practice. We defined the characteristics of each type of visual problem for classification and the criteria for success.

Hoffman LG Rouse MW
"Vision therapy revisited: a restatement." [published erratum appears in *J Am Optom Assoc* 1987 Nov;**58**(1):876] *J Am Optom Assoc* 1987 Jul;**58**(7):536-41

Hohendorf RA
"V.T. survey results." *Michigan Opt* 1983 Dec;**62**(12):8

Kirshner AJ
"Visual training and motivation." *J Am Optom Assoc* 1967;**38**(8):641-5

Liberman J
"Prescribing for performance and prevention." *J Am Optom Assoc* 1976 Aug; **47**(8):1058-64

Lieberman S Pollard S Cooper J et al.
"The utilization of a consulting clinical psychologist within an urban vision training clinic." *Am J Optom Physiol Opt* 1975 Jul;**52**(7):493-6

Multidisciplinary evaluation of children with learning problems is necessary in many cases. The private optometrist frequently has psychological resources available to him and his patients. In an urban setting with an inner city patient population, the clinical practitioner has much difficulty in referring and in retrieving psychological data. The function of a consulting psychologist as an attending staff member of the Visual Training Department of the Optometric Center of New York is described, and a preliminary report of 52 cases referred for psychological consultation between September 1, 1972 and June 30, 1973 is presented.

Long JA 2d Griffin JR Rouse MW
"Vision therapy." [letter] *J Learn Disabil* 1988 Oct;**21**(8):450

Lyons CV Lyons EB
"The power of optometric visual training." *J Am Optom Assoc* 1967; **38**(8):654-60

Macdonald LW
"Implications of critical empathy, primal scream and identity crisis in optometric visual therapy," *J Am Opt Assoc* 1972 Oct;**43**(11):1162-8

Stresses that optometrists, in attempting to modify visual behavior, must be aware of the relationship between various visual behaviors and the total behavioral responses of the patient. At times, during visual training programs, the optometrist may observe patient responses which have come to be called critical empathy. These responses seem akin to observations made through other types of psychotherapy. Optometric tecniques that may produce critical empathy responses are discussed.

Macdonald LW
"Optometric visual training--its history and development." *J Am Optom Assoc* 1970 Oct;**41**(10):828-40

Macdonald LW
"Visual training." Optometric Extension Program Oct 1962 - Sep 1965; **35**(1)-**37**(12)

Matthews JE Smith PB
"Defensive vision training program." Optometric Extension Program 1987 Sep;**59**(12):663

McGraw LG
"Optometric aide's role in training basic visual skills." Optometric Extension Program Apr 1976 - Mar 1979;**18**(1)-20(12)

McGraw LG
"Visualization." Optometric Extension Program Apr 1974 - Mar 1975;**16**(1-12)

McLeod B Hansen E
"Effects of the eyerobics visual skills training program on static balance performance of male and female subjects." *Percept Mot Skills* 1989 Dec;**69**(3):1123

10 male and 10 female students in physical education aged 19 to 23 yr. were each randomly assigned to both the experimental and control groups. Experimental subjects were given the 4-wk Eyerobics visual skills training to assess its effects on static balance performance as measured on a balance stabilometer. Analysis indicated that the women performed significantly better than the men overall. Balance performance by the trained group improved significantly.

Meeker B
"Visual skills: testing and training." Optometric Assistant Courses. Optometric Extension Program Apr 1980 - Mar 1981;**22**(1-12)

Meeker B
"Visual training: a child's case." Optometric Extension Program Apr 1982 - Jul 1982;**24**(1-4)

Milkie GM
"Hypno-ophthalmic therapy--fact or fallacy." *J Am Optom Assoc* 1970 Jul;**41**(7):627-33

Mulholland TB
"Training visual attention." *Acad Therapy* 1974 Fall;**10**(1):5-17

Mullins JB
"A rationale for visual training." *J Am Optom Assoc* 1969 Feb;**40**(2):139-43

Pappas JE
"Modern orthoptic treatment: expectations and limits." *Am Orthopt J* 1987; **37**:45-9

Due to improved understanding of the pathophysiology of strabismus, orthoptists today are better able to select patients who will benefit from orthoptic treatment and to exclude those who are unlikely to be helped by such measures. Amblyopia treatment, antisuppression therapy and exercises aimed at increasing fusional amplitudes can be used alone or as adjuncts to surgery to improve the quality of fusion in patients with fusional potential. The main factors limiting the effectiveness of orthoptic treatment are 10 fusional ability must pre-exist and 2) the patient must be old enough and intelligent enough to understand and carry out the required tasks.

Paris A
"A case for infant vision training." *Opt Mthly* 1983 Jan;**74**(1):38-40

A personal account of an optometrist's involvement in vision therapy for his six-month-old infant is discussed. The case is developed from early diagnosis to conclusion. Specific techniques for remediation are suggested. A detailed history and early diagnosis were keys to success.

Pearlman CA
"A case study." *J Am Optom Assoc* 1976 Mar;**47**(3):396-8

Pickwell LD Jenkins TC
"Orthoptic treatment in teenage patients." *Ophthalmic Physiol Opt* 1982;**2**(3):221-5

A survey of 100 patients who received orthoptic treatment in the Bradford University Clinic is examined to see the level of success with the different binocular anomalies, indicating what factors were common in successful cases, and the type of treatment given. A successful outcome or worthwhile improvement was achieved in enough cases to conclude that orthoptics in teenage patients is often appropriate, even in strabismus, if the cases are selected carefully. There was no indication that the actual age made any difference once the patients was between 11 and 19 years, but the starting acuity was significant.

"Position statement on vision therapy" *J Am Optom Assoc* 1985 Oct;**56**(10):782-3

Provda L
"Vision therapy." [letter] *J Learn Disabil* 1988 Mar;**21**(3):130

Rinaldi SL
"Rinaldi-Larson dynascope: a new pleoptic and orthoptic instrument." *Am Orthopt J* 1967;**17**:88-92

Robertson E
"The Visual Guidance Program: evaluation report." *J Am Optom Assoc* 1977 July:915-919

Rohr A
"A multi-district use of visual training as an instructional approach in elementary education." Optometric Extension Program 1969

Rosofsky AJ
"Optometric visual training: an evaluation." *Opt J Rev Optom* 1974; (111)(22):6-10

Schrock RE
"Introduction to vision training." Optometric Extension Program Oct 1965 - Sep 1967;**38**(1)-**39**(12)

Schrock RE
"Optometric training in action." Optometric Extension Program Oct 1968 - Sep 1972;**41**(1)-**44**(12)

Shankman AL
"Vision enhancement training and mind-body philosophy." Optometric Extension Program Oct 1985-Sep 1986;**58**(1-12)

Skay R
"A change in lifestyle through vision therapy." Optometric Extension Program 1983 Nov;**56**(2):33

Sullivan M
"Orthoptics." *N C Med J* 1983 Oct;**44**(10):655

Swartwout JB
"Organizing visual training stations." *J Am Optom Assoc* 1969 Nov;**40**(11):1121-3

Swartwout JB
"A rationale for the development of parents as optometric home training assistants." *J Am Optom Assoc* 1969 Feb;**40**(2):134-8

Swarthout JB
"A vision training case report." *Research Reports & Special Articles.* Optometric Extension Program 1976 Dec;**49**(3):1

"Symposium on Management of Binocular Anomalies: Efficacy of Vision Therapy. December 10, 1985, Atlanta, Georgia. Proceedings." *Am J Optom Physiol Opt* 1987 Jun;**64**(6):391-429

Veronneau-Troutman S
"A new optical modality to overcome diplopia." *Trans Am Ophthal Soc* 1979;77:181-90

The author has presented a new method to correct vertical diplopia using a prism contact lens. To the present time, its application has been limited to contact lenses correcting refractive errors of less than 3D and to

ground-in prisms of not more than 6 delta. The field is new. Technical, mathematical, and clinical advances should eventually allow the use of stronger prisms over a wider range of refractive corrections.

Vrensen G Cardozo JN
"Changes in size and shape of synaptic connections after visual training: an ultrastructural approach of synaptic plasticity." *Brain Res* 1981 Aug;**218**(1-2):79-97

Waldstreicher, J.S.
"Clinical Experience and Procedures involving visual training and the use of a prism reader type instrument." *J Optom Vis Ther* June 1976; 7(2):6-23

A detailed presentation is given of clinical procedures and experience involving visual training and the use of a prism reader type instrument. Clinical techniques are described for use with the prism reader originally introduced by Taylor and Solan or with any similar near point instrument capable of projecting filmstrips having a controlled vocabulary content and variable speed control along with a phorometer type attachment. The advantages of the use of a prism reader type instrument are discussed along with variations in clinical procedures necessary for different kinds of visual conditions and various types of patients.

Wick B
"Binocular vision therapy for general practice." *J Am Optom Assoc* 1977 Apr;**48**(4):461-6

Guidelines are given for selection of patients who need binocular visual therapy. These guidelines are useful for the optometrist who wishes to start binocular vision training in his practice. Treatment techniques for each type of binocular problem are discussed. Case reports are included which detail diagnosis and treatment.

Wick B
"Vision training for presbyopic nonstrabismic patients." *Am J Optom Physiol* Opt 1977 Apr;**54**(4):244-7

Home vision training was prescribed for 161 presbyopic patients (ages 45 to 89) who had vision-related symptoms and convergence insufficiency or visual skills deficiencies. Most patients required 10 weeks or less of treatment, the longest treatment period being 15 weeks. Elimination of the symptoms and improved responses on certain optometric tests was achieved by 92% of the patients. Evaluation 3 months after therapy indicated that 77 patients required additional training, the older patients requiring it more often, to retain the initial improvement.

Wick B London R
"Analysis of binocular visual function using tests made under binocular conditions." *Am J Optom Physiol Opt* 1987 Apr;**64**(4):227-40

Accommodation and vergence have a complex relation which occasionally breaks down, resulting in a loss of visual efficiency along with symptoms of discomfort associated with use of the eyes. Studies of accommodation/vergence interactions and tonic vergence disorders indicate that, using classical analysis techniques, separate methods are frequently necessary to determine whether existing binocular deficiencies are causing reported symptoms. The problem with current systems of binocular visual function analysis is that the vergence error which exists under binocular conditions is often not the same as that which is measured under monocular conditions. A rationale for, and technique of, analyzing binocular function using results of tests made under binocular conditions is described. This analysis incorporates the concepts of CA/C, proximal vergence (PV), and fixation disparity along with several accommodative measures (facility, lag,

sustaining ability, and accuracy). By identifying relevant binocular components and the interrelations, the clinician should be better able to assess the contribution of each and examine which may be modified most easily by vision therapy, lenses, and/or prism intervention.

Wick B Ryan JB
"Clinical aspects of cyclophoria: definition, diagnosis, therapy." *J Am Optom Assoc* 1982 Dec;**53**(12):987-95

Cyclodeviations are rotations of the eye about an anterioposterior axis. Cyclorotations are either manifest deviations (cyclotropia) or latent (cyclophoria). Perhaps 5% of patients have symptoms related to uncompensated cyclophoria. Diagnostic techniques include fixation disparity evaluation combined with binocular refraction at distance and near. Biofeedback with afterimages, cyclovergence training, surgery, and multiple eyewear are some possible treatment methods.

Wiener H
"Mirror rotations, presented at the Skeffington Symposium." January 1972. *J Opt Vis Dev* 1982 Dec;**13**(4)10-1

Wilson WK
"Optometric vision therapy - a case report." Research Reports and Special Articles, Optometric Extension Program 1977 Jan;**49**(4):1

Wold RM Pierce JR Keddington J
"Effectiveness of optometric vision therapy." *J Am Optom Assoc* 1978 Sep;**49**(9):1047-54

One hundred consecutive optometric vision therapy patients' records were evaluated to determine what changes occurred in the visual processing system. An ordinal visual performance scale was utilized to rate visual functioning on a one hundred point scale. The scale divides the visual processing system into 10 functions of 10 points each. Each of the 10 functions improved at the .001 level of significance as a consequence of the binocular vision therapy treatment program.

Zaki HA
"A comparison between the new and old technique for binocular training." *Bull Ophthal Soc Egypt* 1970;**63**(67):233-5

MYOPIA CONTROL
VISUAL & BEHAVIORAL TRAINING

Balliet R Clay A Blood K
"The training of visual acuity in myopia." *J Am Optom Assoc* 1982 Sep; **53**(9):719-24

Seventeen myopes were trained with a computerized optometer to increase their far-point visual acuity from up to 20/800 to 20/25 for limited durations under conditions where "squinting" and pupil size were controlled. No associated changes in refraction were found. The results are best explained by the formation of an artificial contact lens resulting from tear-film changes. Measuring contrast sensitivity across a range of spatial frequencies is suggested to investigate the possibility that a learned perceptual process may also be involved.

Berman P Levinger S Massoth N et al.
"The effectiveness of biofeedback visual training as a viable method of treatment and reduction of myopia." *J Optom Vis Dev* 1985 Dec;**16**(4):17-21

Trachtman has developed a method of biofeedback training to improve visual acuity in individuals diagnosed as being myopic. This present study was designed to replicate Trachtman's findings and assess the predictability of visual gain as well as the possibility of differential training effects. Results support Trachtman's claim that biofeedback visual training involving the Accommotrac Instrument, developed by Trachtman as well, is an effective method for improving visual acuity. In addition, results based on the present data indicate that visual gain can be predicted fairly accurately and varies as a function of pretraining visual acuity.

Birnbaum MH
"Management of the low myopia pediatric patient." *J Am Optom Assoc* 1979 Nov;**50**(11):1281-9

A review of the literature on myopia etiology indicates that environmental factors, particularly those related to nearpoint use of the eyes, appear to play a significant role. A regimen is described for control of environmental factors producing myopic progression, including use of bifocal lenses to reduce accomodative demand, visual hygiene to foster accommodative relaxation, and vision training to develop adequate accommodative skills and freedom of action between accommodative and convergence systems.

Blount RL Baer RA Collins FL
"Improving visual acuity in a myopic child: assessing compliance and effectiveness." *Behav Res Ther* 1984;**22**(1):53-7

Improvements in visual acuity following vision training were evaluated for an 11 1/2 yr-old myopic male. Initial increases inthe distance at which the S could discriminate letters were found. However, performance began to deteriorate as training progrressed. A negative-reinforcement procedure was employed in order to rule out motivational factors potentially related to this decreased performance. Using a changing criterion within an ABCBC reversal design, the distance at which the S correctly discriminated letters increased by more than 4 times and was clearly related to the reinforcement procedure.

Collins FL Blount RL Gil KM
"An automated trainer for improving visual acuity in myopic adults." *Behav Res Meth Instru* 1982 Oct;**14**(5):438-40

Several studies have found training procedures derived from the experimental analysis of behavior to result in improved visual acuity for myopic adults. The present paper describes an automated trainer that incorporates critical training components and eliminated excessive time demands of the fading and feedback procedures reported in the literature. Implications for standardization and long-term training are discussed.

Collins FL Epstein LH Hannay JH
"A component analysis of an operant training program for improving visual acuity in myopic students." *Behav Ther* 1981;**12**:692-701

Collins FL Epstein LH Hannay JH
"Modification of myopia using fading and feedback: a case study." *Behav Therapist* 1979;**2**:28-9

Collins FL Gil KM
"Critical issues in the evaluation of behavioral training for myopia: a reply to Matson, Helsel, and LaGrow." *Behav Res Ther* 1984b;**22**:195-6

Collins FL Gil KM Pbert LA
"Improving visual acuity in myopia." *Behav Med Abstr* 1984;**5**:142-4

Collins FL Pbert LA Sharp B et al.
"Visual acuity improvement following fading and feedback training - I: comparison of myopia and emmetropic volunteers." *Beh Res Ther* 1988 Nov;**26**(6):461-6

18 myopes and 18 emmetropes were randomlyassigned in pairs to either Fading and Feedback training or a no-treatment control condition. The emmetropes were fitted with plus lenses equivalent to tthe spherical correction of the paired myoipe to simulate myopic visual acuity. Extensive visual acuity measures were obtained pre- and post-training. Data analysis indicated significant increases in recognition visual acuity for trained subjects, compared to no-treatment controls. The myopia/emmetropia variable did not interact with training even though there were noticably greater increases in visual acuity for trained myopes compared tothe other conditions. Resolution visual ascuity did not change as aa function of training. These data are discussed in terms of their implications for better understanding the mechanisms responsible for visual acuity increases following behavioural training.

Collins FL Ricci JA Burkett PA
"Behavioral training for myopia: long-term maintenance of improved acuity." *Behav Res Ther* 1981;**19**:265-8

Two female myopic students participated in a behavioral training program designed to improve visual acuity. Following a 3-day baseline, each subject underwent 12 days of training involving stimulus fading and feedback. Acuity measures were taken daily during baseline and training phases and weekly for more than 2 months following the termination of training. Both subjects showed improved acuity as a function of the training program and this improvement was maintained throughout the followup period. The results are discussed with respect to the growing body of research evaluating behavioral training for myopia.

Epstein LH Collins FL Hannay JH et al.
"Fading and feedback in the modification of visual acuity." *J Behav Med* 1978;1:273-87

Epstein LH Greenwald DJ Hennon D et al.
"Monocular fading and feedback training: effects on visual changes in the trained and untrained eye." *Behav Mod* **5**:171-86

Friedman E
"Vision training program for myopia management." *Am J Optom Physiol Opt* 1981 Jul;**58**(7):546-53.

The use of vision training to stabilize myopia appears to be helpful for many patients, while remaining ineffective for others. The myopia management approach discussed here includes minimum use of full-powered concave corrective lenses, maximum use of convex training glasses, adherence to specific visual hygiene and visuobehavioral guedelines, and a short intense program of home and office visual accommodative convergence (ACA) and visuobehavioral responses.

Giddings JW Lanyon RI
"Effect of reinforcement of visual acuity in myopic adults." *Am J Optom Physiol Opt* 1973 Jun;**51**:181-6

In two experiments, attempts were made to improve visual acuity through reinforcement. In Experiment I, four myopic subjects were given five blocks of 24 trials in a conditioning task. The target stimuli were slides of Landolt rings, with 14 different sizes (increasing on a logarithmic scale) and 12 different stimuli representing each size. Trial blocks of contingent social approval for a correct response were alternated with noncontingent blocks in which approval was delivered randomly. Results permitted the inference that contingent approval resulted in increased acuity. In Experiment II, essentially the same task was used to compare the performance of three groups of subjects (each N=20): contingent reinforcement, noncontingent response, and no-response control. Results showed a nonsignificant increase in acuity and a significant decrease in refractive error. Possible directions for further research are discussed, and ethical considerations are noted.

Gil KM Collins FL
"Behavioral training for myopia, generalization of effects." *Behav Res Ther* 1983 May;**21**(3):269-73

The present study assessed generalization of training effects using a computer system (VCS) as a training medium for modifying acuity. Eighteen myopic volunteers were matched according to pre-training acuity and assigned to either a fading and feedback training group or a practice only control. Subjects were pre- and post-tested on three measures: the Snellen Letter Chart, a Behavioral Acuity Test, and a performance test with the VCS. Compared to control, trained subjects displayed significant improvements in acuity on the Behavioral Acuity Test. These results suggest that training effects generalize to untrained stimuli. Implications for the clinical implement of behavioral training procedures for modifying myopia are discussed.

Gil KM Collins FL Odom JV
"The effects of behavioral vision training on multiple aspects of visual functioning." *J Behav Med* **9**:373-87

Grosvenor TP
"Can myopia be controlled? Part 2 - The Bates system of eye exercises." *Opt Mthly* 1980;**71**(9):545-9

Harris P
"Myopia control in China." Optometric Extension Program 1981 Apr; **53**(7):1-4

Leung JP Lai JSM Hsu WCW
"Generalization of the effects of behavioral training for myopia." *Behav Res Ther* 1987;**25**(2):159-63

The present study assessed generalization of training effects for myopia using a multiple-baseline across-S design. Six biligual Chinese students were recruited and divided into three pairs, each of which was exposed to a different baseline. During the treatment phase, a procedure including stimulus fading, verbal reinforcement and feedback was used to train Ss to identify 50 Chinese characters presented from a distance. The dependent measures included a Chinese Behavioral Acuity Test (BAT) and an English BAT. The training was effective in improvig performances on both tests during treatment and training. Unlike the behavioral measures, refract6ive errors of both eyes assessed before and after treatment showed only slight changes in half of the Ss. Together, these results suggest that effects of visual training only partially generalized to untrained stimuli. Implications for the interpretation of existing data and the direction of future research are discussed.

Matson JL Helsel WJ LaGrow SJ
"Training visual efficiency in myopic persons." *Behav Res Ther* 1983 Mar; **21**(2):115-8

Twenty-four myopic college students were paired into groups based on degree of visual impairment using the Snellen Illiterate E. One member of each pair was then assigned to a no-treatment control group or a training program consisting of fading, social reinforcement and performance feedback. Results on trained stimuli (Snellen Illiterate E) were significantly different across experimental conditions at posttest while differences across experimental conditions at posttest on untrained stimuli (Snellen Letters) were not significant. The implications of these data are discussed with reference to areas for additional research.

Pbert LA Collins FL Smith S
"Visual acuity improvement following fading and feedback training-II. Relationship to changes in refractive error." *Behav Res Ther* 1988; **26**(6):467-73

The present study evaluated the effects of behavioral training on visual acuity and refractive error in myopic adults. Twenty volunteers were matched on the basis of refractive error and one member of each matched pair was randomly assigned to either Fading and Feedback training or a no-treatment control condition. Visual acuity was measured with both recognition and resolution measures. Refractive error was measured subjectively using the LaserSpec optometer, and objectively by to retinoscopic examinations performed by an ophthalmologist with and without cycloplegia. The results indicated significant increases in recognition visual acuity, but not resolution visual acuity for trained subjects compared to the no-treatment controls. Trained subjects did not show improvement in refractive error on any measure, and refractive error changes were not correlated with changes in either measuire of visual acuity. These data suggest that the visual acuity improvements typically found with behavioral training are not associated with changes in refractive error.

Randle RJ
"Responses of myopes to volitional control training of accommodation." *Ophthal Physiol Opt* 1988 Jul;**8**(3):333-40

Twelve young, low myopes were trained to control volitionally their accommodation responses and to achieve clear focus on visual targets moved progressively outward in optical distance. The trainees participated in from 15 to 40 daily training sessions (mean = 28 sessions). All demonstrated volitional control with varying degrees of control authority. Though three of the trainees were unsuccessful, the group achieved a statistically reliable extention of their far points. Post-training optometric examinations were reliably improved over pre-training examinations, but did not appear to be commensurate with the large gains in far-point extension. It was hypothesized that the learned skill may have

been "instrument specific", i.e. it might not fully generalize to significantly improved post-training binocular performance unless it were accomplished by clinical assistance to transfer the training.

Rehm D
"The Myopter viewer: an instrument for treating and preventing myopia." *Am J Optom Physiol Opt* 1975 May;**52**(5):347-50

A new instrument has been developed for utilization in attempts at myopia therapy and control. The inventor discusses instrument design and treatment procedures, and suggests an explanation for the movement of juvenile eyes from hypermetropia into myopia.

Ricci JA Collins FL
"Visual acuity improvement following fading and feedback training - III: effects on acuity for stimuli in the natural environment." Behav Res Ther 1988 Nov;26(6):475-80

The effectiveness of Fading and Feedback training for improving visual performance of myopic volunteers was evaluated using a randomized control design. Forty-eight myopic volunteers were randomly assigned to one of four treatments: Fading and Feedback Training, Fading and Feedback Training plus Incentives, No Training, or No Training plus Incentives. Subjects were pre- and post-tested on three measures of visual function: Performance--subjects played a video "pong" game for a brief period of time; Facial Expression Identification--subjects were asked to locate four household items placed on tables in a room. Subjects in the training condition significantly improved in their ability to recognize facial expression and identify household objects. This occurred with or without incentives for training tasks, incentives alone resulted in improved acuity in the absence of training. These data are discussed in terms of generalizability of Fading and Feedback Training to stimuli in the natural environment.

Rosen RC Schiffman HR Meyers H
"Behavioral treatment of myopia: refractive error and acuity changes in relation to axial length and intraocular pressure." *Am J Optom Physiol Opt* 1984 Feb;**61**(2):101-5

A controlled outcome study on the effects of behavioral training on several measures of visual performance was conducted. Twenty-nine myopic subjects received complete optometric evaluations before being randomly assigned to one of three experimental groups. One treatment group received a behavioral training program with a feedback and reward component, another group received a behavioral training without feedback and reward, and the third group was the no-treatment control group. In addition to measuring the effects of training on visual acuity and refraction, independent measures of axial length and intraocular pressure (IOP) were obtained for all subjects before and after treatment. An analysis of covariance indicated that axial length plays a significant role inmediating the effects of training.

Rosenthal AR Von Noorden GK
"Clinical findings and therapy in unilateral high myopia associated with amblyopia." *Am J Ophthal* 1971 Apr;**71**(4):873-9

Rotberg MH Suwit RS
"Biofeedback techniques for the treatment of visual and ophthalmologic disorders." *Biofeedback Self-Reg* 1981;**6**(3):375-88

The literature on the use of biofeedback techniques in the treatment of visual and opthalmologic disorders is reviewed. Although this consists mainly of case studies, there is mounting evidence that biofeedback may be applicable to the treatment of strabismus, nystagmus, blepharospasm, elevated intraocular pressure, and myopia. Because of the success in applying biofeedback techniques in the treatment of other neuromuscular disorders,

it is concluded that the use of these techniques in the treatment of blepharospasm and strabismus shows the most promise.

Sato T
"Prevention of school myopia." *Ind J Ophthal* 1983;**31** Suppl:813-5

Selenow A Ciuffreda KJ
"Vision function recovery during orthoptic therapy in an exotropic amblyope with high unilateral myopia." *Am J Optom Physiol Opt* 1983 Aug; 60(8):659-66

Orthoptic therapy was instituted in a 6 1/2-year-old patient having deep amblyopia, constant exotropia, and high unilateral myopia. The combination of these factors pointed toward a poor prognosis for attainment of normal monocular and binocular vision function. Rates of recovery of several vision functions were monitored during orthoptic therapy. Results showed marked improvement in most areas, thus providing evidence of neural plasticity at multiple sites in the visual pathways.

Tractman JN
"Biofeedback of accommodation to reduce functional myopia: a case report." *Am J Optom Physiol Opt* 1978;**55**:400-86

A 30-yr-old man received biofeedback training of his accommodation to reduce his functional myopia. There were seven training sessions for a total of 34 min. Each training session consisted of a baseline level recording period followed by a feedback period, a second baseline recording period, and then a second feedback period. Reduction of the functional myopia was learned within a few minutes. Since the training was conducted in a dark environment, myopia reduction was not expected in an illuminated environment. Nonetheless, some generalization was demonstated with a reduction in the subjective measures of myopia (about 1 D for the right eye, 0.50 D for the left eye) and improvement in unaided visual acuity (from about 20/50 to 20/30 for each eye).

Trachtman JN Giambalvo V Feldman J
"Biofeedback of accommodation to reduce functional myopia: a case report." *Biofeedback Self-Reg* 1981;**6**:546-64

Functional myopia may be defined as the refractive condition of the eye due to spasm of the ciliary muscle. As a result of ciliary muscle spasm, the crystalline lens becomes more convex, creating a myopic refractive condition. The normal increase and decrease in refractive power of the crystalline lens is known as accommodation and is controlled by autonomic nervous system innervation to the ciliary muscle. Previous studies have reported that voluntary control of accommodation is possible by biofeedback training (Cornsweet & Crane, 1973; Randle, 1970). The present research investigated the application of biofeedback control of accommodation to reduce functional myopia. A double-reversal, multiple-baseline design was used to conduct the experiment. The results revealed that the three adult male subjects achieved the preset criterion, a 1/2 diopter reduction from initial baseline to a subsequent baseline. Further analysis of the data revealed even greater changes between initial baseline and feedback periods. Although generalization to a nonexperimental environment was not trained, each subject showed a reduction in myopia and an increase in visual acuity. The results of the experiment clearly demonstrated that functional myopia is subject to voluntary control.

Wintermeyer, DH
"Use of accommodative therapy in the treatment of pseudomyopia." *J Opt Vis Dev* 1982 Dec;**13**(4):17-9

The normal classroom activity of a fifth-grader who desires to be a high-achiever in her educational tasks, in addition to reading two to three

hours a day, results in complaints of distance blur mimicking the development of myopia. The use of accommodative theraputic exercises, dilligently adhered to by the patient, results in an improvement in visual acuity with a reduction in myopic signs and symptoms. Etiology of complaints may have been from an accommodative dysfunction.

ACCOMMODATION

Allen MJ
"Accommodative rock via computer." *J Am Optom Assoc* 1988 Aug;**59**(8):610-3

A technique is presented for using a computer for the measurement as well as the training of accommodative facility. The testing and training are accomplished optically without any mechanically moving parts.

Bobier WR Sivak JG
"Orthoptic treatment of subjects showing slow accommodative responses." *Am J Optom Physiol Opt* 1983 Aug;**60**(8):678-87

Five subjects showing slow accommodative responses were given orthoptic treatment. Speed of accommodative response improved after 3 to 6 weeks. No regressions were evident 18 weeks after the cessation of training. Slow accommodative responses were found in subjects with normal phorias and fusion limits. The technique of dynamic photorefraction is introduced for the clinical measurement of accommodative time characteristics.

Cooper J Feldman J Selenow A et al.
"Reduction of asthenopia after accommodative facility training." *Am J Optom Physiol Opt* 1987 Jun;**64**(6):430-6

Five patients reporting asthenopia secondary to accommodative deficiencies underwent automated accommodative facility training. A matched-subjects, crossover design was used to control for placebo effects. All patients receiving automated accommodative training showed a marked increase in accommodative amplitude along with concurrent reduction of asthenopia. Decreases of blur and increases of reading time were the most frequently reported changes by patients. This experiment shows the effectiveness of automated accommodative training in reducing asthenopia and improving accommodative facility.

Cornsweet TN Crane HD
"Training the visual accommodation system." *Vision Res* 1973 Mar;**13**(3):713-5

Daum KM
"Orthoptic treatment in patients with inertia of accommodation." *Aust J Optom* 1983 Mar;**66**(2):68-72

A retrospective analysis of the records of 14 patients diagnosed as having inertia of accommodation has been completed. The patients were most likely to report blurred near vision, facility of accommodation problems, headaches and asthenopia. In addition to a sluggish accommodative system, the accommodative amplitudes were slightly less than expected for the patient's age, the near point of convergence slightly extended and the fusional vergences slightly reduced. With orthoptic training, the facility and amplitude of accommodation and the recovery finding for the near positive fusional vergence were found to have improved significantly. Most patients (90%) obtained some relief with treatment, and 30% achieved a total alleviation of the difficulties. The condition and current state of treatment of inertia of accommodation are briefly discussed.

Daum KM
"Predicting results in the orthoptic treatment of acommodative dysfunction." *Am J Optom Physiol Opt* 1984;**61**(3)184-9

A retrospective analysis of the records of 114 orthoptic patients diagnosed as having accommodative dysfunction, (accommmodative insufficiency, fatigue

of accommodation, infacility of accommodation, or spasm of accommodation) has allowed the construction of models of the results of orthoptic treatment. Discriminant analysis completed on various samples of the group provides linearized discriminant functions for the success of the treatment either total or partial/none and for the change in accommodative amplitude. These data indicate that linearized discriminant functions using the age and AC/A ratio of the patient are effective in postpredicting the success catagory of 60% of a calibration sample of 99 patients. Similar functions using the patients age, initial accommodative amplitude, and blur value of the near positive vergences all the postprediction of the catagory of change in accommodative amplitude with treatment (3 D or more vs 2 D or less). Seventy-eight percents of a sample of 68 patients were correctly classified. The application of these models in predicting the results of treatment of similarly afflicted subjects is discussed.

Duckman RH
"Accommodation in cerebral palsy: function and remediation." *J Am Opt Assoc* 1984 Apr;**55**(4):281-3

Accommodation function in a population of severely involved cerebral palsied children, is significantly impaired or absent. This observation suggests that lowered amplitudes and accommodation facility could be part of the cerebral palsy syndrome and untrainable. This paper looks at the accommodative function and the results of vision training on such a pop ulation.

Goldrich SG
"Emergent textural contours: a new technique for visual monitoring in nystagmus, oculomotor dysfunction, and accommodative disorders." *Am J Optom Physiol Opt* 1981 Jun;**58**(6):451-9.

Emergent textural contours, the perceptual effect seen during continuous rotation of symmetrical arrays of uniform pattern elements, provide a unique source of visual feedback for eye movements and resolutional states and have potential for use as a new clinical tool. The phenomenon is produced by a combination of factors including the effects of visual persistence and differential resolution. A total of 28 subjects including 17 normals, 4 nystagmus, 4 oculomotor dysfunction, and 3 accommodative facility cases were shown an emergent textural contour with an instrument (the Goldrich Contour Rotator) for its display. Subjects were enabled to monitor their own eye movements and accommodative training. Nystagmus subjects were provided with a continuous source of visual input reflecting their ocular oscillations and a determination of the null point of nystagmus was made with the instrument.

Grisham JD
"A short program for accommodative insufficiency." *Rev Opt* 1978 May; **115**(5):35.

A fairly common complaint - even among non-presbyopes - is the inability to maintain a comfortable focus during prolonged periods of reading. A short accommodative facility training program can often bring symptomatic relief and enhance focusing responses. This report demonstrates the characteristics of accommodative insufficiency and the typical course of improvement through training.

Hoffman LG
"The effect of accommodative deficiencies on the developmental level of perceptual skills." *Am J Optom Physiol Opt* 1982 Mar;**59**(3):254-62

The relation of accommodative to visual-motor perceptual abilities was investigated. Patients between 5 and 13 years of age manifesting both accommodative and visual-motor perceptual deficits were given accommodative therapy. The effect of this therapy was analyzed, and the results indicated

that improvement in the visual and motor perceptual abilities occurred in the 5 to 7 years, 11 month age group.

Hung GK Ciuffreda KJ Semmlow JL
"Static vergence and accommodation: population norms and orthoptics effects." *Doc Ophthalmol* 1986 Feb 28;**62**(2):165-79

The steady-state characteristics of the accommodation and vergence systems can be described by a model with six major oculomotor parameters. These include the system biases (tonic vergence and accommodation) and forward-loop gains (vergence and accommodative gains), as well as the interactive system gains (AC/A and CA/C ratios). We investigated these parameters in two populations: (1) 22 visually-normal asymptomatic individuals, and (2) 21 visually abnormal symptomatic individuals before and after conventional orthoptic therapy. Two parameters related to system gain differentiated between the symptomatic and asymptomatic individuals: the slope of the fixation disparity curve with accommodation open-looped and the slope of the accommodative response/stimulus curve. Following orthoptic therapy, 4 static model parameters and 1 dynamic clinical parameter showed changes toward the normal mean; this included tonic accommodation, slope of the fixation disparity curve with accommodation closed-loop (2.5D), slope of the accommodative response/stimulus curve, the CA/C ratio, and the +/- 2D monocular accommodative flipper rate.

Levine S Ciuffreda KJ Selenow A Flax N
"Clinical assessment of accommodative facility in symptomatic and asymptomatic individuals." *J Am Optom Assoc* 1985 Apr;**56**(4):286-90

Clinical assessment of accommodative facility, using +/- 2.00 diopter flippers monocularly, was performed in asymptomatic and symptomatic populations in either single test sessions or multiple daily test sessions. In single session results, there was a trend for the average accommodative flipper rate to decrease as symptom level increased. The cut-off symptomatic/asymptomatic accommodative flipper rate was about 11 cycles per minute. In multiple session results, the average accommodative flipper rate, independent of symptom level, took approximately one week to asymptote to a stable level, with performance remaining at this level two weeks after termination of daily test sessions. Variability in daily flipper rate increased as symptom level increased. These results demonstrate the clinical usefulness of the +/- 2.00 diopter monocular flipper test in the screening for accommodative dysfunction.

Liu JS Lee M Jang J et al.
"Objective assessment of accommodation orthoptics. I. Dynamic insufficiency." *Am J Optom Physiol Opt* 1979 May;**56**(5):285-94

Three young adult females with symptoms related to focusing difficulties at near were treated by standard orthoptic procedures, including jump focus, plus-and-minus lens flippers, and pencil pushups. Home training was done 20 minutes each day for 4 1/2--7 weeks. Objective measures of dynamic accommodation were made each week in our Neuro-optometry Clinic. Initially, these objective measures showed prolongations of time constants and latencies of accommodation. During treatment, the patients showed significant reductions in time constants and latencies that correlated well with elimination of subjective symptoms. Also, in all three patients, flipper rates increased and symptoms were either markedly diminished or no longer present at termination of therapy. These results clearly demonstrate that orthoptic treatment in our three adult patients resulted in objective improvement of accommodation function.

Ludlam WM Ludlam DE
"Effects of prism-induced, accommodative convergence stress on reading comprehension test scores." *J Am Optom Assoc* 1988 Jun;**59**(6):440-5

Forty-eight binocular, non-presbyopic optometry students, unfamiliar with the purposes of the study, were provided with several matched passages of material to read in a given time sequence. Multiple choice questions were to be answered at the completion of each reading passage. These were administered in a randomly counterbalanced presentation (a b b a) utilizing either base-in prism or plano lenses in spectacle form. The results of this experiment showed a statistically significant lower comprehension rate with the base-in prism lenses in place as evidenced by fewer correct answers to the questions following the reading passages. This effect was found to be greater for the longer reading passages followed by a greater number of questions to be answered.

Manor RS
"Use of special glasses in treatment of spasm of near reflex." *Ann. Ophthalmol.* 1979;**11**:903-908

Spasm of near reflex manifests itself in attacks of convergence, accommodation and miosis. It is frequently misdiagnosed as bilateral sixth nerve palsy. In many instances treatment of the accommodative element of the spasm of near reflex does not give a prompt result and thus fails to dissipate the suspicion of the neurosurgeon concerning the presence of "abducens palsy." One patient having spasm of near reflex was given eyeglasses in which the inner third of each lens had been made opaque. It was rationalized that the patient would be forced to choose one of two alternatives: a continuation of the spasm of near reflex and see nothing (in convergence both eyes being blocked by the opaque glass), or interruption of the spasm of convergence with straightening of the eyes and to be able to see through the transparent middle part of the eyeglasses. In this patient there was an immediate straightening of the eyes with a concommitant disappearance of the headaches and diplopia. The good results obtained in this patient would seem to justify additional trials in using eyeglasses with an opaque inner third of each lens in similar patients.

Pierce J Greenspan S
"Accommodative rock procedures in vision training, a clinical guide." *Optom Wkly* 1971;**62**(34):776-80

Pierce J Greenspan S
"Accommodative rock procedures in vision training, a clinical guide." *Optom Wkly* 1972;**62**(33):754-7

Randle RJ
"Responses of myopes to volitional control training of accommodation." *Ophth Physiol Opt* 1988 Jul;**8**(3):333-40

Twelve young, low myopes were trained to control volitionally their accommodation responses and to achieve clear focus on visual targets moved progressively outward in optical distance. The trainees participated in from 15 to 40 daily training sessions (mean = 28 sessions). All demonstrated volitional control with varying degrees of control authority. Though three of the trainees were unsuccessful, the group achieved a statistically reliable extention of their far points. Post-training optometric examinations were reliably improved over pre-training examinations, but did not appear to be commensurate with the large gains in far-point extension. It was hypothesized that the learned skill may have been "instrument specific", i.e. it might not fully generalize to significantly improved post-training binocular performance unless it were accomplished by clinical assistance to transfer the training.

Rouse MW
"Management of binocular anomalies: efficacy of vision therapy in the treatment of accommodative deficiencies." *Am J Optom Physiol Opt* 1987 Jun;**64**(6):415-20

This paper is a review of the literature supporting vision therapy as an effective treatment mode for accommodative deficiencies. Vision therapy procedures have been shown to improve accommodative function effectively and eliminate or reduce associated symptoms. In addition, the actual physiological accommodative response variables modified by the therapy have been identified, eliminating the possibility of Hawthorne or placebo effects accounting for treatment success. Finally, the improved accommodative function appears to be fairly durable after treatment.

Rutstein RP Daum KM Amos JF
"Accommodative spasm: a study of 17 cases." *J Am Optom Assoc* 1988 Jul; **59**(7):527-38

Accommodative spasm (AS) is rarely reported in the literature. We studied 17 patients with accommodative spasm. Most patients were clinically emmetropic. Ten patients also manifested a spasm of the near reflex (SNR). The probable etiology of the accommodative disorder for most patients was psychogenic as revealed by case histories and visual field analysis. Treatment consisted primarily of plus reading lenses and, in some instances, orthoptic training. Some patients also underwent psychological counseling. Followup ranged from 2 months to 30 months. Although visual symptoms improved for most patients, only four patients had complete resolution of the spasm.

Scott WE Mash AJ Redmond MR
"Comparison of accommodative and non-accommodative targets for the assessment of ocular deviations." *Am Orthopt J* 1976; **26**:83-6

Suchoff IB Petito GT
"The efficacy of visual therapy: accommodative disorders and non-strabismic anomalies of binocular vision." *J Am Optom Assoc* 1986 Feb;**57**(2):119-25

Questions concerning the effectiveness of therapeutic intervention designed to modify the function of an individual's visual system have been raised by professional groups, consumer groups, insurance carriers, students, educators, as well as "pure" scientists. This paper examines the available literature in order to answer the question, "Is there evidence that 'orthoptics' or 'vision therapy' causes changes in an individual's accommodative or vergence eye movement systems?" This review neither examines alternative methods of causing these changes nor provides information concerning which particular techniques are most effective, although the literature does provide such information. Certain conditions are explained to aid the student and lay-reader in understanding the literature cited. The literature cited substantiates that visual therapy can modify visual functions and also points out the relationship of these changes to the relief of certain symptoms.

Tractman JN
"Biofeedback of accommodation to reduce functional myopia: a case report." *Am J Optom Physiol Opt* 1978;**55**:400-86

A 30-yr-old man received biofeedback training of his accommodation to reduce his functional myopia. There were seven training sessions for a total of 34 min. Each training session consisted of a base-line level recording period followed by a feedback period, a second baseline recording period, and then a second feedback period. Reduction of the functional myopia was learned within a few minutes. Since the training was conducted in a dark environment, myopia reduction was not expected in an illuminated environment. Nonetheless, some generalization was demonstated with a reduction in the subjective measures of myopia (about 1 D for the right eye, 0.50 D for the left eye) and improvement in unaided visual acuity (from about 20/50 to 20/30 for each eye).

Tractman JN
"Perceptual correlates of accommodative biofeedback training." *Research Reports & Special Articles*, Optometric Extension Program 1986 Dec; **59**(3):1

Weisz CL
"Clinical therapy for accommodative responses: transfer effects upon performance." *J Am Optom Assoc* 1979;**50**:209-21

Weisz CL
"How to find and treat accommodative disorders." *Rev Optom* 1983;**120**(1): 48-54

VERGENCE

Burian HM Brown AW
"Unusual adverse effect of prismatic corrections in a child with divergence insufficiency." *Am J Ophthalmol* 1972 Aug;**74**(2):336-9

Cooper J Feldman J
"Operant conditioning of fusional convergence ranges using random dot stereograms." *Am J Optom Physiol Opt* 1980 Apr;**57**(4):205-13

In Experiment 1, four 6- to 10-year-old strabismus patients, who had failed to improve convergence ranges using traditional vision training techniques, were given convergence training using random dot stereograms (RDS). An integral part of the RDS training procedure was the incorporation of an operant conditioning procedure providing for response-contingent positive reinforcement, immediate feedback, and pre-programmed systematic changes in convergence demand during discrimination learning. Findings indicated that operant RDS convergence training produced a significant increase in convergence ranges which transferred readily to vectogram tasks and resulted in a change from exotropia to exophoria for at least one patient. In Experiment 2, it was shown that improved convergence ability was a direct result of exposure to RDS of increasing convergence demand. It was concluded that young, uncooperative, language-deficient, or inattentive patients show improved convergence ranges when such training incorporates proper stimuli and the basic principles of learning and motivation into its training regimen.

Cooper J Selenow A Ciuffreda KJ et al.
"Reduction of asthenopia in patients with convergence insufficiency after fusional vergence training." *Am J Optom Physiol Opt* 1983 Dec; 60(12):982-9

Seven patients with convergence insufficiency and related asthenopia underwent automated fusional convergence training. A matched-subjects control group crossover design was used to reduce placebo effects. All patients showed significant increases in vergence ranges with concur-rent marked reduction of symptoms after training. All patients showed a flattening of and an increase in the base-out portion of their fixation disparity curve. Our results demonstrated the effectiveness of fusional vergence training in reducing asthenopia in these patients. Subsequent accommodation and vergence training using traditional orthoptic procedures yielded further reduction of asthenopia, as well as an increase in the base-out fusional range.

Daum KM
"A comparison of the results of tonic and phasic vergence training." *Am J Optom Physiol Opt* 1983 Sep;**60**(9):769-775

Thirty-four healthy asymptomatic young adults wre randomly divided into two groups. All subjects underwent training aimed at expanding the vergence ranges. The training in one group consisted of tasks emphasizing smooth, slow activities. The other group trained using quicker, stepwise, more phasic tasks. The vergence ranges were subjectively measured using a small (1.72° diameter) target in a major amblyoscope. The study lasted 6 weeks. The first 3 weeks served as a control period over which time the vergences proved to be stable. The training was done for 10 min on the weekdays of the last 3 weeks of the study. Analysis of the data indicates that the group training via the stepwise or phasic paradigm showed greater increases in both the positive and negative vergences. Both groups achieved substantial increases in both the negative and positive vergences. The significance of these results is discussed.

Daum KM
"The course and effect of visual training on the vergence system." *Am J Optom Physiol Opt* 1982 Mar;**59**(3):223-7

The effect of a variety of vergence training procedures on the visual system of 35 asymptomatic young adults with normal binocularity was evaluated. The visual training took place on the weekdays of three consecutive weeks. Vergence ranges were measured before the study began and at the end of the 3-week period. Subpopulations were evaluated at one week and at 6 months to document further the course of the effects. Positive fusional vergence training significantly increased the vergence ranges after 1 week of training; a greater effect was measured after 3 weeks. The vergence capability was found to have decreased 6 months later, but the effects of the training were still apparent. Negative fusional vergence training was less effective; however, significant increases were demonstrable after 3 weeks of training. The phorias and the accommodative amplitude were not affected by the orthoptics. We conclude that relatively short periods of training can provide long lasting increases in the vergence ability of a group of binocular normals. The implications of such findings relative to possible neural control mechanisms and clinical visual training situations are discussed.

Daum KM
"Negative vergence training in humans." *Am J Optom Physiol Opt* 1986 Jul;**63**(7):487-96

Two healthy subjects (male and female, ages 22 and 25 years) spent 50 hours over a period of 7 consecutive weeks training the negative vergence system. The training was performed in two 45-min daily sessions, usually immediately before and after the workday. The training was exclusively negative vergence training using devices such as variable vectograms, the aperture rule, the synoptophore, and loose or bar prisms. An extensive examination of the visual systems before, after, and periodically during the training demonstrated that the negative vergences increased at distance by 5.0 delta and at near by 9.1 delta (using handheld prisms, barprisms, and the synoptophore). The phorias of both subjects became more exophoric or less esophoric at both distance and near by 3.6 delta (using average of changes on the cover test, von Graefe subjective phoria technique, and the synoptophore). A haploscope equipped with a coincidence optometer showed only small increases in vergence amplitude but confirmed that the lag of accommodation became more stable after the training than it was before. Other testing suggested that the negative relative accommodation, the angle of deviation at both distance and near, positive vergences, the associated phoria, and the slope of the fixation disparity curve changed significantly over the period of training. I conclude that negative vergence training can increase the negative vergence capabilities and also affect the phoria position of the eyes via feedback into the slow vergence system.

Griffin JR
"Efficacy of vision therapy for nonstrabismic vergence anomalies." *Am J Optom Physiol Opt* 1987 Jun;**64**(6):411-4

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.

Griffin JR Hattan MA Hertneky RL
"Vision therapy with stereoscopic motion pictures, a comparative evaluation." *Am J Optom Physiol Opt* 1982 Nov;**59**(11):890-9

The Cine-Ortho method is compared with a standard regiman for improving base-in and base-out vergence ranges at far. No significant difference was found between the two types of training. Base-out ranges were significantly improved by either method, but there was no significant improvement in base-in ranges in three training sessions.

Hung GK Ciuffreda KJ Semmlow JL
"Static vergence and accommodation: population norms and orthoptics effects." *Doc Ophthal* 1986 Feb 28;**62**(2):165-79

The steady-state characteristics of the accommodation and vergence systems can be described by a model with six major oculomotor parameters. These include the system biases (tonic vergence and accommodation) and forward-loop gains (vergence and accommodative gains), as well as the interactive system gains (AC/A and CA/C ratios). We investigated these parameters in two populations: (1) 22 visually-normal asymptomatic individuals, and (2) 21 visually abnormal symptomatic individuals before and after conventional orthoptic therapy. Two parameters related to system gain differentiated between the symptomatic and asymptomatic individuals: the slope of the fixation disparity curve with accommodation openlooped and the slope of the accommodative response/stimulus curve. Following orthoptic therapy, 4 static model parameters and 1 dynamic clinical parameter showed changes toward the normal mean; this included tonic accommodation, slope of the fixation disparity curve with accommodation closed-loop (2.5D), slope of the accommodative response/stimulus curve, the CA/C ratio, and the +/- 2D monocular accommodative flipper rate.

London RF Wick B
"Vertical fixation disparity correction: effect on the horizontal forced-vergence fixation disparity curve." *Am J Optom Physiol Opt* 1987 Sep; **64**(9):653-6

Following a suggestion made by Percival in regard to dissociated phorias, we corrected vertical associated phoria in several patients who had disparities in both vertical and horizontal fixation. The principal objective result of this correction was a flattening of the slope of the type I horizontal forced-vergence curve. This result may be significant particularly because the slope has been identified as being a good prognosticator of patients likely to be symptomatic. Attention to a concurrent vertical component may offer a convenient way to normalize a steep slope on horizontal fixation disparity curves.

Ludlam WM Ludlam DE
"Effects of prism-induced, accommodative convergence stress on reading comprehension test scores." *J Am Optom Assoc* 1988 Jun;**59**(6):440-5

Forty-eight binocular, non-presbyopic optometry students, unfamiliar with the purposes of the study, were provided with several matched passages of material to read in a given time sequence. Multiple choice questions were to be answered at the completion of each reading passage. These were administered in a randomly counterbalanced presentation (a b b a) utilizing either base-in prism or plano lenses in spectacle form. The results of this experiment showed a statistically significant lower comprehension rate with the base-in prism lenses in place as evidenced by fewer correct answers to the questions following the reading passages. This effect was found to be greater for the longer reading passages followed by a greater number of questions to be answered.

Major D Pirotte P
"Duction training with a microcomputer: a comparative study." Optometric Extension Program 1985 Dec;**58**(3):1

Mannen DL Bannon MJ Septon RD
"Effects of base-out training on proximal convergence." *Am J Optom Physiol Opt* 1981;**58**:1187-93

Proximal convergence/nearness ratio were determined before and after a program of base-out training. Ratios using base-out vergence, phoria, and base-in vergence data were found to fall after training while the base-out limit increased dramatically. Since the ACA's did not change, it was concluded that it is not the awareness of nearness that is enchanced in such training, but the amplitude of fusional convergence.

Manor RS
"Use of special glasses in treatment of spasm of near reflex." *Ann Ophthal* 1979;**11**:903-908

Spasm of near reflex manifests itself in attacks of convergence, accommodation and miosis. It is frequently misdiagnosed as bilateral sixth nerve palsy. In many instances treatment of the accommodative element of the spasm of near reflex does not give a prompt result and thus fails to dissipate the suspicion of the neurosurgeon concerning the presence of "abducens palsy." One patient having spasm of near reflex was given eyeglasses in which the inner third of each lens had been made opaque. It was rationalized that the patient would be forced to choose one of two alternatives: a continuation of the spasm of near reflex and see nothing (in convergence both eyes being blocked by the opaque glass), or interruption of the spasm of convergence with straightening of the eyes and to be able to see through the transparent middle part of the eyeglasses. In this patient there was an immediate straightening of the eyes with a concommitant disappearance of the headaches and diplopia. The good results obtained in this patient would seem to justify additional trials in using eyeglasses with an opaque inner third of each lens in similar patients.

Pickwell LD
"Prevalence and management of divergence excess." *Am J Optom Physiol Opt* 1979 Feb;**56**(2):78-81

The prevalence of divergence excess was assessed from the records of 250 consecutive patients attending a binocular vision clinic. The 67 cases in the sample showing divergence excess were subdivided into the following groups: (1) secondary to operations for esotropia (8 cases); (2) anisometropic amblyopes (14 cases); (3) basic (14 cases); (4) convergence weakness (13 cases); (5) divergence excess (18 cases). Treatment methods placed heavy emphasis on physiological diplopia. Of the 18 in the divergence excess category, 14 began treatment, 10 showed a satisfactory outcome, two achieved some improvement, and two discontinued treatment on their own. Divergence excess seems to respond well to nonsurgical treatment.

Robertson KM Kuhn L
"Effect of visual training on the vertical vergence amplitude." *Am J Optom Physiol Opt* 1985 Oct;**62**(10):659-68

Visual training has an effect on the vertical vergence amplitudes. Three mature symptomatic patients exhibited a significant increase in the vertical vergence which compensates for the vertical heterophoria. Subjects with normal binocularity and hence no vertical heterophoria did not exhibit increased vertical vergence amplitudes after training.

Rutstein RP Daum KM Cho M et al.
"Horizontal and vertical vergence training and its effect on vergences, fixation disparity curves, and prism adaptation: II. Vertical data." *Am J Optom Physiol Opt* 1988 Jan;**65**(1):8-13

The purpose of this study was to assess the effects of horizontal and vertical vergence training on vertical fusional amplitudes, the vertical fixation disparity (VFD) curve, and prism adaptation. Thirty-four subjects were divided into three groups. One-third served as controls and the other two-thirds underwent 5 h of supervised horizontal and vertical vergence training, respectively. We hypothesized that subjects in the vertical group would manifest increased vertical vergence amplitude and coefficients of adaptation in concert with flatter VFD slopes. Before and after the 4-week training period, vertical vergences, fixation disparity (FD) curves, and coefficients of vertical prism adaptation were measured by a single individual who was intentionally uninformed of each subject's group. Analysis of the data suggests that changes in the vertical fusional amplitudes increased slightly. Although changes in the VFD slope and coefficient of prism adaptation were not statistically significant, the

changes were much greater in the vertical group and in the hypothesized direction. We suggest that the results offer preliminary support for our hypothesis.

Scheiman M Gallaway M Ciner E
"Divergence insufficiency: characteristics, diagnosis, and treatment." *Am J Optom Physiol Opt* 1986 Jun;**63**(6):425-31

Although the entity of divergence insufficiency was described as early as 1886 by Duane, it has received relatively little attention in the literature. Patients presenting with a greater eso deviation at distance than at near, a concomitant deviation, and diplopia pose a challenging and critical diagnostic and therapeutic puzzle for the clinician. Divergence insufficiency, a benign condition, must be differentiated from divergence paralysis and sixth nerve palsy, two conditions that present with somewhat similar findings yet have underlying etiologies of a serious nature. This paper reviews the literature and clarifies the etiology, diagnosis, and treatment of divergence insufficiency and related conditions.

Scheiman MM Peli E Libassi D
"Auditory biofeedback used to enhance convergence insufficiency therapy." *J Am Optom Assoc* 1983 Nov;**54**(11):1001-3

Vaegan JL
"Convergence and divergence show large and sustained improvement after short isometric exercise." *Am J Optom Physiol Opt* 1979 Jan;**56**(1):23-33

There are conflicting reports on the effect of vergence training. In two studies using push up and prism vergence exercises the conflict is shown to result from differences in the constancy of effort. Improvement only occurs in exercises involving sustained effort in the direction being trained. The effect of alternating movements in both directions is small and inconsistent. Substantial long lasting gains in either convergence or divergence prism vergence scores can result from just 5 min of sustained effort at an angle halfway between the break and recovery points. Results for adults and children on motor-driven instruments are comparable and the scores obtained discriminate better than those from hand-turned instruments. The most likely physiological model involves potentiating processes which are specifically maximized by isometric exercise. Potentiation results in a positive feedback process, the effects of which are strong enough to precipitate strabismus and which might be deliberately manipulated in therapy of poor vergence control, if responses in the required direction can be induced.

Vaegan JL McMonnies C
"Clinical vergence training." *Aust J Optom* 1979 Jan;**62**(1):28-36

Various forms of vergence training were tested as part of an orthoptic programme. Three clinical studies from this programme are reported which, when taken in conjuction with the results of separate laboratory studies, support the view that exercises in which vergence angle varies widely and rapidly have a small and even detrimental effect, while those in which a fixed vergence angle is held for a prolonged time improves the prism vergence ability in the direction of previous effort. This effect is analogous to the physiological mechanism of potentiation which is particularly emphasized in isometric exercise.

Viikari K
"Minus or plus lenses in the therapy of the convergence spasm?" [letter] *J Clin Neuro Ophthalmol* 1984 Mar;**4**(1):71-2

CONVERGENCE INSUFFICIENCY

Anderson EC
"Treatment of convergence insufficiency: a review." *Am Orthopt J* 1969; **19**:72-7

Cohen AH Soden R
"Effectiveness of visual therapy for convergence insufficiencies for an adult population." *Am J Optom Assoc* 1984 Jul;**55**(7):491-4

> Visual therapy has long been considered an appropriate treatment for children with functional problems. The authors have expanded the parameters of effectiveness to include adults with convergence insufficiency.

Cooper J
"Review of computerized orthoptics with specific regard to convergence insufficiency." *Am J Optom Physiol Opt* 1988 Jun;**65**(6):455-63

> Traditional vision training or orthoptics has used line or contour targets to eliminate suppression and improve vergence performance. Manipulation of these stimuli is slow and arduous. Line stimuli require an experienced doctor/technician to interpret responses. Recently, automated vision training using microprocessor anaglyph stimuli, i.e., random dot stereograms (RDS), has been used in an operant conditioning paradigm. This technique has improved motivation of the patient, improved reliability, and provided standardization of therapy. In addition, the utilization of RDS associated with operant conditioning has been shown to improve vergence performance and to reduce asthenopia in the convergence insufficiency patient.

Cooper J Duckman R
"Convergence insufficiency: incidence, diagnosis and treatment." *J Am Optom Assoc* 1978;**49**:673-80

Cooper J Selenow A Ciuffreda KJ et al.
"Reduction of asthenopia in patients with convergence insufficiency after fusional vergence training." *Am J Optom Physiol Opt* 1983 Dec; 60(12):982-9

> Seven patients with convergence insufficiency and related asthenopia underwent automated fusional convergence training. A matched-subjects control group crossover design was used to reduce placebo effects. All patients showed significant increases in vergence ranges with concurrent marked reduction of symptoms after training. All patients showed a flattening of and an increase in the base-out portion of their fixation disparity curve. Our results demonstrated the effectiveness of fusional vergence training in reducing asthenopia in these patients. Subsequent accommodation and vergence training using traditional orthoptic procedures yielded further reduction of asthenopia, as well as an increase in the base-out fusional range.

Dalziel CC
"Effect of vision training on patients who fail Sheard's criterion." *Am J Optom Physiol Opt* 1981 Jan;**58**(1):21-3

> One hundred convergence insufficiency patients who did not meet Sheard's criterion at near were given a program of in-office and at-home training. The objective was to see if they would meet Sheard's criterion after training. Results were analyzed in terms of the numbers successfully meeting this criterion as well as other criteria, i.e. Percival's, elimination of symptoms, improvement of stereopsis, and elimination of fixation

disparity. Of the 100 patients, 84 successfully met Sheard's criterion after therapy. Failure to meet Sheard's criterion correlated well with having subjective symptoms.

Daum KM
"Classification criterion for success in the treatment of convergence insufficiency." *Am J Optom Physiol Opt* 1984 Jan;**61**(1):10-15

Using data collected from a retrospective study of the records of 110 patients diagnosed as having convergence insufficiency, a model has been developed which allows the classification of a patient into one of two categories of success (total or partial/none) on the basis of an initial examination. The subjects were treated with orthoptics and classified into either the total success group (no objective or subjective visual difficulties) or the partial/no success group. Stepwise discriminant analysis was used in the data reduction phase in which 6 of 14 possible variables were selected which best explained the variation in the degree of success. These six variables were (1) the AC/A ratio; (2) the negative vergence blur value at 40 cm; (3) the recovery value of the positive vergences at 6 m; (4) the break value of the positive vergence at 6 m; (5) the amplitude of accommodation; and (6) the frequency of the deviation. Subjects were more likely to be successful when 1, 2 and 3 were high, 4 and 5 were low, and the deviation was latent. Discriminant analysis using these six variables allowed 25 of 33 (76%) of the patients to be correctly classified in terms of their success. The applicaton of the model for classifying patients with convergence insufficiency is presented and briefly discussed.

Grisham JD
"Visual therapy results for convergence insufficiency: a literature review." *Am J Optom Physiol Opt* 1988 Jun;**65**(6):448-54

This paper is a review of the literature relative to treatment results for convergence insufficiency utilizing vision therapy training procedures. Vision therapy is shown to improve the nearpoint of convergence and fusional convergence and to ameliorate associated symptoms. The overall cure rate is 72%. Furthermore, the training results appear to persist for at least 2 years if the patients are initially cured and are independent of age until the late presbyopic years. Also, recent studies indicate the type of training procedures which yield the most effective training results.

Mohindra I
"Diagnosis and management of convergence insufficiency." *Opt Month* 1980 Nov;**71**(11):625-8

Mohindra I
"Management, diagnosis, and prognosis of convergence insufficiency: a case report - part 1." *Opt Month* 1980;**71**(8):484-6.

The case of an 8-year-old boy is presented - the results of his eye examination.

Mohindra I
"Management, diagnosis, and prognosis of convergence insufficiency: a case report - part 2." *Opt Month* 1980;**71**(9):530-3.

The case of an 8-year-old boy with convergence insufficiency is presented with prognosis, management, and weekly progress reports.

Mohindra I Molinari J
"Convergence insufficiency: its diagnosis and management - part 1." *Opt Month* 1980;**71**(3):155-60.

The symptoms of convergence insufficiency are described and the tests and other factors used in diagnosis are explained.

Mohindra I Molinari J
"Convergence insufficiency: its diagnosis and management - part 2." *Opt Month* 1980;**71**(4):222-5.

Management of refractive errors, fusional convergence amplitudes, and accommodative facility at near working distances are discussed.

Mohindra I Molinari J
"Convergence insufficiency: its diagnosis and management - part 3." *Opt Month* 1980;**71**(5):310-3.

The management of fusional and accommodative facilities beyond near distances and of relative convergence is discussed as well as surgery and base-in prism prescriptions.

North RV
"Effect of orthoptics upon the ability of patients to adapt to prism-induced heterophoria." *Am J Optom Physiol Opt* 1982 Dec;**59**(12):983-86

In a previous study we showed that subjects with abnormal binocular vision either lacked or had a deficient ability to adapt their oculomotor systems to a prism-induced heterophoria. In this study we report on the results of an experiment designed to establish whether the adaptation ability improves in patients who are successfully treated, by means of orthoptics, for convergence insufficiency. In all seven patients examined, we found an improved ability to adapt. Whereas at the beginning of the experiment only two patients fell within the 95% confidence limits of the norm, at the end five patients fell within these limits. These results demonstrate that the success of orthoptics in relieving symptoms is associated with an improved ability to adapt to prism-induced heterophoria.

Pantano FM
"Orthoptic treatment of convergence insufficiency: a two year follow-up report." *Am Orthopt J* 1982;**32**:73-80

One theory of the etiology of convergence insufficiency is the presence of an underlying low AC/A ratio. In this study there were 207 patients with varying degrees of convergence insufficiency. It was clinically demonstrated that their asthenopia was caused by using excessive accommodative rather than fusional convergence. They were treated with home stereograms and followed for a two year period after treatment had been discontinued. Only those patients who progressed to the point of developing both fusional and voluntary convergence, indicated by their performance on the stereograms, maintained their increased convergence amplitude and remained asymptomatic for at least two years after treatment. These results indicate that a permanent alteration of the AC/A ratio had taken place.

Scheiman MM Peli E Libassi D
"Auditory biofeedback used to enhance convergence insufficiency therapy." *J Am Optom Assoc* 1983 Nov;**54**(11):1001-3

STEREOPSIS

Boman DK Kertesz AE
"Effect of stimulus parameters on fusional and stereoscopic performance." *Am J Optom Physiol Opt* 1985 Mar;**62**(3):222-7

The effect of stimulus size and complexity on the horizontal divergent diplopia threshold, stereoscopic range, reappearance of stereopsis, and refusion point was examined. It was found that the addition of random-dot (RD) backgrounds significantly increased both the diplopia threshold and refusion point, whereas the further addition of multiple depth planes did not. Stereopsis and diplopia were found to coexist in RD stereograms both when the disparity increased past the diplopia threshold and when it was decreasing toward the refusion point. This suggests that monocularly distinguishable contours must be added to RD stereograms to render them suitable for the measurement of fusional amplitudes.

Cooper J Feldman J
"Operant conditioning of fusional convergence ranges using random dot stereograms." *Am J Optom Physiol* Opt 1980 Apr;**57**(4):205-13

In Experiment 1, four 6- to 10-year-old strabismus patients, who had failed to improve convergence ranges using traditional vision training techniques, were given convergence training using random dot stereograms (RDS). An integral part of the RDS training procedure was the incorporation of an operant conditioning procedure providing for response-contingent positive reinforcement, immediate feedback, and preprogrammed systematic changes in convergence demand during discrimination learning. Findings indicated that operant RDS convergence training produced a significant increase in convergence ranges which transferred readily to vectogram tasks and resulted in a change from exotropia to exophoria for at least one patient. In Experiment 2, it was shown that improved convergence ability was a direct result of exposure to RDS of increasing convergence demand. It was concluded that young, uncooperative, language-deficient, or inattentive patients show improved convergence ranges when such training incorporates proper stimuli and the basic principles of learning and motivation into its training regimen.

London R Wick B
"Modification of the RanDot stereogram for greater clinical reliability." *J Am Optom Assoc* 1981 Nov;**52**(11):875-6

Mohindra I Zwaan J Held R et al.
"Development of acuity and stereopsis in infants with esotropia." *Ophthalmology* 1985 May;**92**(5):691-7

Visual acuity and stereopsis of 19 esotropic infants and toddlers, 36 normal infants and 7 children with refractive anomalies were measured during the first three years of life using newly developed preferential looking procedures. Children with infantile esotropia corrected with prisms equal in size to the deviation show some degree of binocularity up to at least 21/2 years, as measured by a polaroid bar stereogram procedure with a 1800 seconds of arc disparity. A few children, who did not receive any therapeutic intervention, failed this test during the first and second year. However, all older subjects (over 6 years of age) with a history of infantile esotropia failed the test.

Rosner J Clift GD
"The validity of the Frisby Stereotest as a measure of precise stereoacuity." *J Am Optom Assoc* 1984 Jul;**55**(7):505-6

This paper reports the outcomes of a study that compared the per-formance of 20 binocular adults on the Frisby steereotest and the TNO. (All subjects

were prescreened with the Random-Dot E stereotest administered at 1.5 m.) Significant intercorrelations were found (Pearson r = .73; two-tailed p < .001), adding support to the clinical usefulness of the Frisby stereotest. Other characteristics of the two tests - including communication requirements and administration time - are compared.

Saladin JJ Alspaugh DH Penrod LR
"Effect of vision therapy on stereophotogrammetric profiling--a controlled clinical trial." *Am J Optom Physiol Opt* 1988 May;**65**(5):325-30

A single, masked controlled clinical trial showed that vision therapy improved both the accuracy and repeatability of stereophotogrammetric performance on the profiling task with experienced, visually normal observers. The average fixation disparity measured under working conditions decreased and stereoscopic acuity as measured with a Howard-Dolman apparatus increased. The data suggest that vision therapy is most helpful for those profiling situations in which disparity stimuli are plentiful and stereopsis is the dominant depth cue.

Simmerman JS
"Absolute threshold of stereopsis using the Frisby Stereotest." *J Am Optom Assoc* 1984 Jan;**55**(1):50-3

Threshold of stereopsis was measured using the Frisby stereotest on 20 subjects exhibiting normal binocular vision, and 3 subjects known to be strabismic. Results obtaained are comparabble with values found in the literature for other real-depth tests.

Tillson G
"Two new clinical tests for stereopsis." *Am Orthopt J* 1985;**35**:126-34

This paper describes two new methods of testing stereopsis. The Lang stereo-test which is used to assess stereopsis at 40 cm. without the use of any dissociating glasses and the Braddick random-dot slides which are used in conjunction with a major amblyoscope. The results obtained with these tests are compared with more well known tests, e.g. the Titmus stereotest, T.N.O. test, A.O. Vectograph and with slides from the Clement Clarke Ltd. series "D" major amblyoscope slides for stereopsis, in an attempt to assess their place in the investigation of binocular function.

Vodnoy Bs
"Clinical application of stereopsis in diagnosis and orthoptics." *Rev Opt* 1977 Feb;**114**(2):74-7.

Wittenberg S
"Brock's research in stereopsis." *Am J Optom Physiol Opt* 1981 Aug;**58**(8):663-6

While Frederick Brock's contributions to vision training are numerous, little of his work dealt specifically with stereopsis, mostly concentrating on its application to diagnosis and therapy of binocular dysfunction. He did demonstrate, qualitatively, how differences in the size or clarity of retinal images affect stereopsis. The theoretical basis of his work, as well as his published and unpublished contributions, are reviewed in the context of the author's personal experience with this singular person.

Wittenberg S Brock FW Folson WC
"Effect of training on stereoscopic acuity." *Am J Optom Arch Am Acad Optom* 1969 Sep;**46**(9):645-53

The ability to train stereoscopic acuity has not been tested. Indirect evidence arising as a byproduct of other studies has been inconclusive. The purpose of this study was to determine if stereoscopic acuity could, in

fact, be improved by training. A group of 16 subjects was measured with stereoscopic cards in a telebinocular and divided into a control and an experimental section. The latter underwent training in an instrument in which they repeatedly adjusted one virtual object to lie in tha same fronto-parallel plane as another virtual object. Post training retest showed both groups to have im-proved performance. The experimental section demonstrated far greater improvement, a difference statistically significant at the 0.01 level, indicating that stereoscopic acuity had been improved by training.

EYE MOVEMENTS

Ciuffreda KJ Goldrich SG
"Oculomotor biofeedback therapy." *Int Rehabil Med* 1983;**5**(3):111-7

Biofeedback therapy refers to the process of gaining voluntary control over some bodily function by the immediate use of information regarding its physiological state. In this paper we review the use of oculomotor biofeedback therapy in three common ocular disorders: nystagmus, strabismus, and amblyopia. Experimental and clinical test results have been encouraging. We believe oculomotor biofeedback therapy should be attempted, either alone or in conjunction with orthoptic and/surgical procedures, in these and other ocular disorders manifesting an abnormal oculomotor component.

Ciufredda KJ Goldrich SG Neary C
"Use of eye movement auditory feedback in the control of nystagmus." *Am J Optom Physiol Opt* 1982 May;**59**(5):396-409

Eye movement auditory biofeedback was used in weekly training sessions to control nystagmus in five adult patients. Within the 1st hour of training, all patients were able to reduce nystagmus. Average maximum group reduction of nystagmus amplitude, peak slow-phase velocity, and frequency achieved during training with auditory biofeedback was 82, 86, and 34%, respectively. At periodic intervals during training, audio information was withheld and patients were able to maintain reduced nystagmus for several minutes. In addtion patients were able to reduce nystagmus upon command without audio cues but with conscious effort while engaging in conversation and other tasks with the experimenters. Visual acuity improvement with consicious patient effort to control nystagmus but without auditory biofeedback averaged 10% Snell-Sterling. One of two patients who returned for post-training reevaluation was able to reduce his nystagmus quickly without auditory biofeedback to 50% of the pretraining level, and both patients were able with the aid of auditory cues to reduce their nystagmus rapidly to the level achieved during training. In addition to the improvement in vision, cosmetic and psychological benefits accrued. Eye movement auditory biofeedback should be considered in the treatment of nystagmus, either alone or in conjuction with orthoptic and/or surgical procedures.

Ciuffreda KJ Kenyon RV Stark L
"Abnormal saccadic substitution during small-amplitude pursuit tracking in amblyopic eyes." *Invest Ophthalmol Vis Sci* 1979 May;**18**(5):506-16

Small-amplitude, low-velocity, predictable triangular tracking was tested in patients having amblyopia without strabismus, intermittent strabismus, or constant strabismus amblyopia by means of a photoelectric eye-movement recording technique. In the majority of amblyopic patients, abnormal saccadic substitution was found; that is, abnormally large saccades rather than small-amplitude smooth movements were used by the amblyopic eye to follow a spot stimulus that moved horizontally with low to high frequencies. Pursuit for the same range of stimuli was normal for binocular tracking and for monocular tracking with the dominant eye, pointing to a sensory rather than motor basis for the defect. This abnormal saccadic substitution response appeared to be related to the presence of amblyopia rather than strabismus. Several possible mechanisms responsible for causing this unusual response are discussed, including impairment of direction sense over small central regions of the amblyopic eye.

Ciuffreda KJ Kenyon RV Stark L
"Different rates of functional recovery of eye movements during orthoptics treatment in an adult amblyope." *Inv Ophthal Vis Sci* 1979 Feb;**18**(2):213-9

Although it is common clinical knowledge that oculomotor control appears to normalize during the course of successful orthoptics therapy for amblyopia, reports providing a quantitative analysis of eye movements during extended periods of treatment are lacking. We provide for the first time such a report in an adult amblyope. Aspects of eye movement control that tended to normalize with therapy include drift amplitude and velocity, duration and frequency of steady fixation, and pursuit gain. These results suggest that smooth pursuit control can be modified, even in an adult amblyope. Aspects of eye movement control that remained abnormal throughout therapy, in spite of normalization of visual acuity and centralization of fixation, include increased saccadic latencies, use of large saccades during small-amplitude pursuit tracking, and static overshooting. These results suggest that certain aspects of saccadic and pursuit control could either no longer be modified or would require longer periods for this to occur.

Ciuffreda KJ Kenyon RV Stark L
"Fixational eye movements in amblyopia and strabismus." *J Am Optom Assoc* 1979 Nov;**50**(11):1251-8

Horizontal eye position was monitored using a photoelectric method during monocular and binocular fixation in four patients having amblyopia without strabismus, thirteen patients having constant strabismus with amblyopia, and five patients having intermittent strabismus. Four abnormalities of fixation were found: increased drift, saccadic intrusions, manifest nystagmus, and latent nystagmus. Increased drift was related to the presence of amblyopia, while saccadic intrusions and nystagmus were related to the presence of strabismus. Understanding dynamic aspects of oculomotor control can provide insight into clinical assessment of fixation in amblyopia and strabismus.

Ciufredda KJ Kenyon RV Stark L
"Suppression of fixational saccades in strabismic and anisometropic amblyopia." *Ophthal Res* 1979;**11**:31-9

Forrest EB
"Eye scan therapy for astigmatism." *J Am Optom Assoc* 1984 Dec;**55**(12):894-901

Two earlier papers introduced a new model of functional astigmatism. The investigation that led to the model indicated a relationship exists between meridional eye scanning habits and the formation of functional astigmatism. The present paper reviews the model and describes a clinical study involving the prescribing of specific eye scan therapy on a meridional basis. The results demonstrate that ther-apy involving eye scanning procedures has a positive effect on the control and reduction of astigmatism.

Fujimoto DH Christensen EA Griffin JR
"An investigation in use of videocassette techniques for enhancement of saccadic eye movements." *J Am Optom Assoc* 1985 Apr;**56**(4):304-8

An investigation exploring the potential for the therapeutic application of videocassette techniques in vision therapy was undertaken. It was shown that a saccadic therapy program could be designed and produced with reasonable ease and simplicity. Clinical trials revealed the video method of saccadic therapy to be as effective as a standaard method of therapy as to a significant change in saccadic ability. For validation of the research method, a control group was given pre- and post-testing; no significant change was found.

Garzia RP Richman JE Nicholson SB et al.
"A new visual-verbal saccade test: the Developmental Eye Movement test (DEM)." *J Am Optom Assoc* 1990 Feb;**61**(2)::124-35

The use of presently available clinical oculomotor tests of a visual-verbal format are limited because they do not evaluate automaticity of number naming. There is a significant relationshiip between automaticity of number naming and reading performance. Presented is a new oculomotor test that has a specific method to factor out the consequences of automaticity on oculomotor performance. Normative data for children age 6-13 years is provided, in addition to reliability and validity information., Clinical utilization of this test for diagnosis and management in visually related learning problems is offered.

Goldrich SG
"Emergent textural contours: a new technique for visual monitoring in nystagmus, oculomotor dysfunction, and accommodative disorders." *Am J Optom Physiol Opt* 1981 Jun;**58**(6):451-9.

Emergent textural contours, the perceptual effect seen during continuous rotation of symmetrical arrays of uniform pattern elements, provide a unique source of visual feedback for eye movements and resolutional states and have potential for use as a new clinical tool. The phenomenon is produced by a combination of factors including the effects of visual persistence and differential resolution. A total of 28 subjects including 17 normals 4 nystagmus, 4 oculomotor dysfunction, and 3 accommodative facility cases were shown an emergent textural contour with an instrument (the Goldrich Contour Rotator) for its display. Subjects were enabled to monitor their own eye movements and accommodative training. Nystagmus subjects were provided with a continuous source of visual input reflecting their ocular oscillations and a determination of the null point of nystagmus was made with the instrument.

Griffin JR
"Saccadic eye movements - recommended testing and training procedures." *Opt Month* 1981 Jul;**72**(7):27-8

Punnett AF Steinhauer GD
"Relationship between reinforcement and eye movements during ocular motor training with learning disabled children." *J Learn Disabil* 1984;**17**:16-9

Four reading disabled childen were given eight sessions of ocular motor training with reinforcement and eight sessions without reinforcement. Two reading disabled control Ss were treated similarly but received no ocular motor training. Results demonstrated that reinforrcement can improve ocular motor skills, which in turn elevates reading performance.

Rubin W
"Reverse prism in ocular motility problem$." *Int Ophthal Clin* 1971 Winter;**11**(4):263-8

Savedoff L Weiss J Sturr J et al.
"The effects of "videogame therapy" on children with oculomotor dysfunction." *J Opt Vis Dev* 1985 Jun; **16**(2)15-17

This study evaluated the effects of "videogame therapy" on children with oculomotor dysfunction. Twelve subjects, aged 7-12, served in experimental or control conditions that evaluated performance on the King Devick Saccadic Test (KDST) before and after videogame intervention. There were no improvements in performance suggesting that "videogame therapy" would not be an adequate substitute for conventional vision training.

Sohrab-Jam G
"Eye movement patterns and reading performance in poor readers: immediate effects of convex lenses indicated by book retinoscopy." *Am J Optom Physiol Opt* 1976 Nov;**53**(11):720-6

Eye movement patterns and reading performance were evaluated in 38 4th and 5th grade male students who were at least 1 year behind in their reading levels. Half of the subjects (Group I) demonstrated a need for convex lenses at near by a book retinscopy criterion. The remaining subjects (Group II) showed no need for convex lenses at near by the same criterion. The subject's eye movements during reading were recorded by a commercial device called Eye-Trac. These recordings were made with 2 lens applications, plano and +0.50 D, respectively. The number of fixations, regressions, rate of reading, and relative efficiency for each condition (plano and +0.50 D) were calculated. In Group I, 3 of 5 measures showed significant improvement with plus lenses. These subjects showed fewer regressions, increased reading speed, and higher relative efficiency with plus than without. In Group II, 3 of 5 measures showed decrement with plus lenses, while 1 (com-prehension) showed improvement. These subjects showed more fixations and regressions and lower relative efficiency with plus than without. It is therefore concluded that convex lenses of low power can have considerable immediate effect on children's reading skills, sometimes helpful and sometimes detrimental, and that proper pretesting with book retinoscopy will aid in the prediction of this effect.

Veronneau-Troutman S
"Fresnel prism membrane in acquired extraocular muscle palsy." *Am Orthopt J* 1974;**24**:91-7

von Noorden GK
"Diagnosis and management of eye muscle problems in childhood." *Surg Clin North Am* 1970 Aug;**50**(4):885-94

Young BS
"Effect of eye exercises in improving control of eye movements during reading." *J Opt Vis Devel* 1982 Jun;**13**(2):4-7

This study utilized the total population of the Stephen F. Austin Learning Center- 33 subjects, to a) determine the proportion of dyslexic students suffering from poor binocular control and b) the effect of eye exercise in aiding binocular control and reading efficiency as measured by a moving-eye camera. All subjects were screened for problems in fusion, stereopsis, and lateral posture using the Keystone Visual Survey. Students with deficiences were then pretested, reading recreational level material, with the moving-eye camera. Each student showing deficiencies practised three, 5 minute periods per day on indivdually prescribed exercises from Kaplan (Ch. 1) in addition to 45 minutes of reading instruction. After six weeks, totaling 6 hours of visual therapy, the subjects were post-tested using the moving-eye camera and standardized reading tests. Among the 33 students, 39% showed fusion, stereopsis, or lateral posture problems. Following therapy, statistically significant differences were recorded in a) number of fixations per 100 words, b) number of seconds required to read the 100 word selection, c) number of seconds the right eye was out of voluntary control (moving in a direction contrary to the opposite eye and without relationship to the printed material), d) number of seconds the left eye was out of voluntary control, e) fixation duration. Reading achievement increased slightly despite a 25% reduction in instructional time.

Young LR Sheena D
"Survey of eye movement recording methods." *Behav Res Methods Instrumentation* 1975;**7**:397-429

NYSTAGMUS

Abadi RV Carden D Simpson J
"A new treatment for congenital nystagmus." *Br J Ophthal* 1980;**64**:2-4

> Congenital nystagmus is a disorder of eye movement with an associated reduction in visual acuity. The latter is mainly due to the intensity of the nystagmus (amplitude times frequency) allowing the object of regard to spend only a short time on the fovea. Training patients by an auditory feedback technique to control the nystagmus enables visual sensitivity to improve. This method is compared with present alternatives, and further studies are suggested.

Ciuffreda KJ
"Auditory biofeedback as a potentially important tool in the treatment of nystagmus." *J Am Optom Assoc* 1980 Jun;**51**(6):615-7

Ciuffreda KJ Goldrich S
"Auditory feedback as a potentially important new tool in the treatment of nystagmus." *J Am Opt Assoc* 1980 Nov;**51**(11):1037-9

Ciuffreda KJ Goldrich SG
"Oculomotor biofeedback therapy." *Int Rehabil Med* 1983;**5**(3):111-7

> Biofeedback therapy refers to the process of gaining voluntary control over some bodily function by the immediate use of information regarding its physiological state. In this paper we review the use of oculomotor biofeedback therapy in three common ocular disorders: nystagmus, strabismus, and amblyopia. Experimental and clinical test results have been encouraging. We believe oculomotor biofeedback therapy should be attempted, either alone or in conjunction with orthoptic and/surgical procedures, in these and other ocular disorders manifesting an abnormal oculomotor component.

Ciufredda KJ Goldrich SG Neary C
"Use of eye movement auditory feedback in the control of nystagmus." *Am J Optom Physiol Opt* 1982 May;**59**(5):396-409

> Eye movement auditory biofeedback was used in weekly training sessions to control nystagmus in five adult patients. Within the 1st hour of training, all patients were able to reduce nystagmus. Average maximum group reduction of nystagmus amplitude, peak slow-phase velocity, and frequency achieved during training with auditory biofeedback was 82, 86, and 34%, respectively. At periodic intervals during training, audio information was withheld and patients were able to maintain reduced nystagmus for several minutes. In addtion patients were able to reduce nystagmus upon command without audio cues but with conscious effort while engaging in conversation and other tasks with the experimenters. Visual acuity improvement with consicious patient effort to control nystagmus but without auditory biofeedback averaged 10% Snell-Sterling. One of two patients who returned for post-training reevaluation was able to reduce his nystagmus quickly without auditory biofeedback to 50% of the pre-training level, and both patients were able with the aid of auditory cues to reduce their nystagmus rapidly to the level achieved during training. In addition to the improvement in vision, cosmetic and psychological benefits accrued. Eye movement auditory biofeedback should be considered in the treatment of nystagmus, either alone or in conjuction with orthoptic and/or surgical procedures.

Collins WE
"Special effects of brief periods of visual fixation on nystagmus and sensations of turning." *Aerosp Med* 1968 Mar;**39**(3):257-66

Flom MC Kirschen DG Bedell HE
"Control of unsteady, eccentric fixation in amblyopic eyes by auditory feedback of eye position." *Inv Ophthal Vis Sci* 1980 Nov;**19**(11):1371-81

A technique for providing amblyopes with auditory feedback signals of eye position errors is described. With auditory cues, 12 adult eccentrically fixing amblyopes with strabismus and/or anisometropia have been able to maintain steady and foveal fixation with the amblyopic eye. The changes observed in fixation patterns with auditory feedback were both quantitative and qualitative; with such feedback, amblyopes often exhibited sequences of normal-appearing fixation. Some of our sujects have been successful in maintaining steady foveal fixation for short periods of time after feedback is turned off, apparently using visual error signals. For two subjects, feedback also promoted major improvements in smooth tracking performance. We conclude that the use of auditory feedback of eye position has significant value for basic studies of the mechanisms underlying amblyopia and potentially for the clinical treatment of this condition.

Goldrich SG
"Emergent textural contours: a new technique for visual monitoring in nystagmus, oculomotor dysfunction, and accommodative disorders." *Am J Optom Physiol Opt* 1981 Jun;**58**(6):451-9.

Emergent textural contours, the perceptual effect seen during continuous rotation of symmetrical arrays of uniform pattern elements, provide a unique source of visual feedback for eye movements and resolutional states and have potential for use as a new clinical tool. The phenomenon is produced by a combination of factors including the effects of visual persistence and differential resolution. A total of 28 subjects including 17 normals 4 nystagmus, 4 oculomotor dysfunction, and 3 accommodative facility cases were shown an emergent textural contour with an instrument (the Goldrich Contour Rotator) for its display. Subjects were enabled to monitor their own eye movements and accommodative training. Nystagmus subjects were provided with a continuous source of visual input reflecting their ocular oscillations and a determination of the null point of nystagmus was made with the instrument.

Morrison D Sublett J
"The effects of sensory integration therapy on nystagmus duration, equilibrium reactions and visual-motor integration in reading retarded children." *Child Care Health Dev* 1986 Mar-Apr;**12**(2):99-110

Previous research on the effects of sensory integration therapy on vestibular processing dysfunction has not used an appropriate control group design. Using a control group, this research investigated the effects of sensory integration therapy on nystagmus duration, equilibrium reactions and visual-motor integration in 26 children with reading retardation. The sample had average intelligence but showed depressed nystagmus duration, problems in equilibrium reactions and delays in visual-motor coordination. Sixty-six sessions of therapy did not significantly affect duration, equilibrium or visual-motor integration.

Stegall FW
"Orthoptic aspects of a nystagmus." *Am Orthopt J* 1973;**23**:30-4

Stohler T
"After-image treatment in nystagmus." *Am Orthopt J* 1972;**22**:65-7

ECCENTRIC FIXATION

Burian HM
"Occlusion amblyopia and the development of eccentric fixation in occluded eyes." *Am J Ophthal* 1966 Nov;**62**(5):853-6

Davis MR Hoffman LG
"A three step method of the determination of fixation status and retinal correspondence." *J Am Optom Assoc* 1983 Sep;**54**(9):807-9

In examination and treatment of patients with strabismus one often encounters abnormal sensory adaptations such as eccentric fixation and anomalous retinal correspondence. Prognosis and treatment of strabismus are dependent on the presence or absence of these conditions. When eccentric fixation is present it becomes difficult to interpret the results of many tests used to determine retinal correspondence. This determination is further complicated when the patient is unable to give accurate responses. A technique utilizing visuoscopy and an afterimage has been performed on somewhat less cooperative patients. The results compare favorably to amblyoscopic measurements of the angle of anomaly.

Flom MC Kirschen DG Bedell HE
"Control of unsteady, eccentric fixation in amblyopic eyes by auditory feedback of eye position." *Inv Ophthal Vis Sci* 1980 Nov;**19**(11):1371-81

A technique for providing amblyopes with auditory feedback signals of eye position errors is described. With auditory cues, 12 adult eccentrically fixing amblyopes with strabismus and/or anisometropia have been able to maintain steady and foveal fixation with the amblyopic eye. The changes observed in fixation patterns with auditory feedback were both quantitative and qualitative; with such feedback, amblyopes often exhibited sequences of normal-appearing fixation. Some of our subjects have been successful in maintaining steady foveal fixation for short periods of time after feedback is turned off, apparently using visual error signals. For two subjects, feedback also promoted major improvements in smooth tracking performance. We conclude that the use of auditory feedback of eye position has significant value for basic studies of the mechanisms underlying amblyopia and potentially for the clinical treatment of this condition.

Malik et al.
"The red-filter treatment of eccentric fixation." *Am J Ophth* 1969 Apr; **67**:586-590

The fovea contains the highest population density of cones per unit area and the population density of cones declines sharply with increasing distance from the fovea. Because visual rods are insensitive to light from the extreme red end of the spectrum, the dark adapted eye can be exposed to bright red without loss of dark adaptation and the brightness created by the red light easily allows reading, thus permitting the photopic mechanism to function. Since eccentric fixation is located in a cone poor and rod rich area, the cone rich normal foveal area is preferentially stimulated when a red filter is used. The treatment consists of placing a Kodak-Wratten gelatin red filter 92 before the eyes. The opposite eye is occluded. The patient wears the red filter over his amblyopic eye four hours per day and carries out routine reading and fixation training. The amblyopic eye is occluded during the non-treatment phase. The treatment should be carried out for periods up to 3 or 4 months and has best results on amblyopic patients who have an initial acuity of 20/200 or better.

Malik SR Choudhry S Sen DK
"Red filter in the management of eccentric fixation." *J All India Ophthal Soc* 1969 Dec;**17**(6):250-5

Nawratzki I Oliver M
"Eccentric fixation managed with inverse prism." *Am J Ophthal* 1971 Feb;**71**(2):549

Parks MM Friendly DS
"Treatment of eccentric fixation in children under four years of age." *Am J Ophthal* 1966 Mar;**61**(3):395-9

Schor C Wick B
"Rotating grating treatment of amblyopia with and without eccentric fixation." *J Am Optom Assoc* 1983 Jun;**54**(6):545-9

Treatment of amblyopia with and without eccentric fixation using short term occlusion and rotating gratings was analyzed in a controlled study. A control group (n = 18) viewed a blank rotating disc for 15 minutes once a week for ten weeks while the treatment group (n = 20) observed rotating gratings for the same time period. Both groups performed visually guided tasks to maintain treatment interest. Visual acuity was analyzed before and after each treatment session using a multiple Landolt ring chart. Data were gathered in a double masked manner. Analysis did not reveal a statistically significant improvement of visual acuity with rotating grating therapy for treating amblyopia with or without eccentric fixation.

Tomlinson E Jablonski M
"Results of modified pleoptic therapy in eccentric fixation." *Am Orthopt J* 1973;**23**:60-4

FIXATION DISPARITY

Cooper J Feldman J Horn D et al.
"Reliability of fixation disparity curves." *Am J Optom Physiol* Opt 1981 Nov;**58**(11):960-4

> Fixation disparity curves were recorded in three normal subjects once per week over a period of 10 weeks. Results indicate that measurements of fixation disparity are reliable within limited ranges of forced convergence and forced divergence. Increases in the demand to maintain fusion lead to increases in observed variability of fixation disparity. It is suggested that variability of fixation disparity might be related to the ease with which the two eyes are used as a team.

Eskridge JB Rutstein RP
"Clinical evaluation of vertical fixation disparity. Part IV. Slope and adaptation to vertical prism of vertical heterophoria patients." *Am J Optom Physiol Opt* 1986 Aug;**63**(8):662-7

> The purpose of this study was to determine the characteristics of the cliically measured vertical fixation disparity (VFD) curve and the ability to adapt to vertical prism for patients who have a vertical heterophoria and are comfortably wearing vertical prism, and to relate these data to similar findings for nonvertical heterophoria patients. The correlation between the amount of vertical prism that was being worn comfortably and the amount of vertical prism that reduced the VFD to zero was also evaluated. The results indicate that patients with vertical heterophoria who are wearing vertical prismatic corrections comfortably have VFD curves with shapes and slopes similar to nonvertical heterophoria patients; have lower coefficients of adaptability to vertical prism than nonvertical heterophoria patients; and the amount of the vertical prismatic correction to produce visual comfort can be determined by the vertical prism that reduces the VFD to zero.

London R Wick B
"Relationship between fixation disparity curves and symptoms in monofixators." *J Am Optom Assoc* 1982 Nov;**53**(11):881-4

> Patients with small angle strabismus usually are asymptomatic. Occasionally, however, binocular asthenopic symptoms are reported. Two monofixators, one symptomatic and the other asymptomatic, with similar profiles on strabismic evaluation had forced vergence Fixation Disparity Curves (FDC) measured. Slope of the FDC may help to discriminate between the symptomatic and asymptomatic patient.

London RF Wick B
"Vertical fixation disparity correction: effect on the horizontal forced-vergence fixation disparity curve." *Am J Optom Physiol Opt* 1987 Sep; 64(9):653-6

> Following a suggestion made by Percival in regard to dissociated phorias, we corrected vertical associated phoria in several patients who had disparities in both vertical and horizontal fixation. The principal objective result of this correction was a flattening of the slope of the type I horizontal forced-vergence curve. This result may be significant particularly because the slope has been identified as being a good prognosticator of patients likely to be symptomatic. Attention to a concurrent vertical component may offer a convenient way to normalize a steep slope on horizontal fixation disparity curves.

McKee MC Young DA Kohl P Reinke AR Yolton RL
"Effect of head and eye positions on fixation disparities, phorias, and ductions at near." *Am J Optom Physiol Opt* 1987 Dec;**64**(12):909-15

This study evaluated the effects of head and gaze position on near fixation disparity, phoria, and duction findings. A population of 104 noncomplaining subjects divided by age into 3 groups participated in the study. The primary head and gaze position along with two others approximating the positions used for reading by nonbifocal and bifocal wearers were used. A statistically significant effect was found for the phoria data from the young group, but the magnitude was clinically insignificant. Changes in head and/or gaze positions did not significantly affect fixation disparities or duction recovery ranges. Phorias and fixation disparities showed statistically significant increases in exo deviation with increasing age regardless of head and/or gaze position. Nine of 23 presbyopic subjects gave erratic findings during fixation disparity testing and this casts doubt upon the clinical usefulness of this procedure with presbyopes.

Rutstein RP Daum KM Cho M et al.
"Horizontal and vertical vergence training and its effect on vergences, fixation disparity curves, and prism adaptation: II. Vertical data." *Am J Optom Physiol Opt* 1988 Jan;**65**(1):8-13

The purpose of this study was to assess the effects of horizontal and vertical vergence training on vertical fusional amplitudes, the vertical fixation disparity (VFD) curve, and prism adaptation. Thirty-four subjects were divided into three groups. One-third served as controls and the other two-thirds underwent 5 h of supervised horizontal and vertical vergence training, respectively. We hypothesized that subjects in the vertical group would manifest increased vertical vergence amplitude and coefficients of adaptation in concert with flatter VFD slopes. Before and after the 4-week training period, vertical vergences, fixation disparity (FD) curves, and coefficients of vertical prism adaptation were measured by a single individual who was intentionally uninformed of each subject's group. Analysis of the data suggests that changes in the vertical fusional amplitudes increased slightly. Although changes in the VFD slope and coefficient of prism adaptation were not statistically significant, the changes were much greater in the vertical group and in the hypothesized direction. We suggest that the results offer preliminary support for our hypothesis.

Sheedy JE
"Actual Measurement of fixation disparity and its use in diagnosis and treatment." *J Am Opt Assoc* 1980;**51**(12):1079-84

An instrument and technique are described which, for the first time, enable the eye care practitioner to measure the angle of fixation disparity. A forced vergence fixation disparity curve can be quickly measured in the office. Research findings and patient examples are used to show how a fixation disparity curve is analyzed to diagnose and prescribe for an oculomotor imbalance.

READING

Anapolle L
"Visual training and reading performance." International Reading Association Newark, Delaware. *J Reading* 1967 Mar;10

Visual training is defined as the field of ocular reeducation and rehabilitation of the various visual skills that are of paramount importance to school achievement, automobile driving, outdoor sports activities, and occupation pursuits. A history of orthoptics, the suggested name for the entire field of ocular reeducation, is given. Reading as a visual act is discussed, and the following seven goals of visual training are explained--to develop smooth, rhythmic oculomotor control, to eliminate any tendency for suppression of vision, to build fusion to its highest degree-stereopsis, to train accommodation facility for clear focusing, to improve convergence flexibility for accurate fixation, to train efficient hand and eye coordination skills, and to enhance speed and accuracy of visual perception.

Atzmon D
"Positive effect of improving relative fusional vergence on reading and learning disabilities." *Binoc Vis* 1985 Oct;**1**(1):39

Following ten years of treating children with reading disabilities by orthoptic exercises, the author believes that the cause of some of these problems may be lack of sufficient relative fusional vergences. All children who were treated had had previous reading courses without satisfactory results. However, when fusional vergences reached "optimal" levels, marked progress in reading occured. The author strived for absolute convergence of 60 prism diopters and relative convergence of 30 prism diopters at distance and near, and divergence of 15 prism diopters. Almost all children complained of asthenopia. 150 children ages 4 to 18 were selected at random out of about 800. Followup time was 6 weeks to five years. 66% had exophoria, 7% had esophoria and 27% had orthophoria. In many cases absolute convergence of 40 prism diopters seemed sufficient at near, but at 6m there was convergence of 4-6 prism diopters only. In other cases relative amplitudes were low, and when they improved - performance in reading improved. Of 109 children who finished treatment, 15% reported little or no improvement in one or more aspects at school. But 85% reported improvement in one or more aspects at school: reading, concentration, spelling, handwriting and copying from the blackboard.

Belmont L Flegenheimer H Birch HG
"Comparison of perceptual training and remedial instruction for poor beginning readers." *J Learn Disab* 1973 Apr;**6**(4):230-5

Two matched groups of beginning readers with equivalent degrees of risk for reading failure were provided, respectively, with supplementary perceptual training or remedial instuction using letters and words, in addition to receiving regular first grade classroon insruction. After 7 months of supplementary instruction, both groups had made equivalent advances in reading level, indicating that neither perceptual training nor remedial reading was the superior program.

Bieger E
"Effectiveness of visual perceptual training on reading skills of non readers, an experimental study." *Percept Mot Skills* 1974;**38**:1147-53

48 second and third grade non-readers who were estimated to have perceptual deficiencies were randomly placed in experimental and control groups. The experimental group received perceptual training plus remedial instruction. The control group received only remedial instruction. After 7 months, the low perceivers given visual training improved significantly in

visual perception, but improvements were not reflected in reading achievement. Controls gained 8 mo. in reading achievement versus 6 mo. for experimentals, indicating that perceptual training did not influence the achievement of reading skills for this group.

Christenson GN Griffin JR Wesson MD
"Optometry's role in reading disabilities:resolving the controversy." *J Am Optom Assoc* 1990 May;**61**(5):363-71

Optometry's involvement in the management of reading disabilities is often misunderstood. This paper clarifies the confusion surrounding specific reading disabilities and optometric vision therapy in the management of them. Topics include a historical review of dyslexia, theories of brain function, anda neuroanatomical model, as well as operational definitions and behavioral characteristics of the types of dyslexia. Methods for direct diagnosis of coding deficits in specific reading disability (dyslexia) are discussed. This approach explains the beneficial role of optometric vision therapy in the management of patients with reading problems.

Falik LH
"The effects of special perceptual-motor training in kindergarten on reading readiness and second grade performance." *J Learn Disab* 1969; 2(8):10-7

Flax N Greenspan SB Grisham D et al.
"Is There a Relationship Between Vision Therapy & Academic Achievement? - Part 1." *Rev Opt* 1977 Jun;**114**(6):48-63.

Flax N Greenspan SB Grisham D et al.
"Is There a Relationship Between Vision Therapy & Academic Achievement? - Part 2." *Rev Opt* 1977 Jul;**114**(7):44-52.

Friedhoffer A
"Optometric diagnosis and visual training as they relate to school achievement." *Opt J Rev Optom* 1969 May;**106**:27-31

Frisbie B
"Reading training: the assistant's role." Optometric Extension Program Oct 1965-Sep 1966;7(1-12)

Halliwell JW Solan HA
"The effects of a supplemental perceptual training program on first grade reading achievement." *Except Child* 1972 Apr;**38**:613-22

Three matched groups of first graders were selected. One group received no special instruction, one group received special educational instruction, and the experimental group received perceptual-motor vision therapy. The experimental group achieved significantly superior performance on a standardized achievement test.

Hill PJ
"Child motor skills and academic achievement." *Optom Wkly* 1972 Oct; **63**(41):1004-5

Hulliwell JW Solan HA
"The effects of a supplemental perceptual training program on reading achievement." *Exception Child* 1972;613-21

Krippner S
"On research in visual training and reading disability." *J Learn Disab* 1971;**4**(2):8-17

Lloyd B
"The effects of programmed perceptual training on the reading achievement and mental maturity of selected first grade pupils: A pilot study." *J Read Specialist* 1966;**6**:49-55

"Low plus reading lenses - placebo or panacea?" *Tex Optom* 1986 Feb;**4**(2):10

Lowry RW
"Optometric approach to rapid reading." *Optometric Extension Program* Oct 1963 - Sep 1965;**36**(1)-**37**(12)

Ludlam WM
"Visual training, the alpha activation cycle and reading." *J Am Optom Assoc* 1979 Jan;**50**(1):111-5

Two patients with visual problems and reading difficulties originally unable to suppress alpha have been shown to demonstrate alpha rhythm attenuation during the course of and after a program of visual training with simultaneous improvement in reading performance. No direct training of alpha attenuation was engaged in. No other therapy directed toward solution of the patients reading or behavior problems was attempted during the course of visual training. It is concluded that the change in alpha activation and the improvement in reading were both brought about by the combined visual therapy and reading glasses. Further research concerning the number and proportion in the population of learning disabled who respond similarly to the cited cases is presently being undertaken by the author.

Ludlam WM Ludlam DE
"Effects of prism-induced, accommodative convergence stress on reading comprehension test scores." *J Am Optom Assoc* 1988 Jun;**59**(6):440-5

Forty-eight binocular, non-presbyopic optometry students, unfamiliar with the purposes of the study, were provided with several matched passages of material to read in a given time sequence. Multiple choice questions were to be answered at the completion of each reading passage. These were administered in a randomly counterbalanced presentation (a b b a) utilizing either base-in prism or plano lenses in spectacle form. The results of this experiment showed a statistically significant lower comprehension rate with the base-in prism lenses in place as evidenced by fewer correct answers to the questions following the reading passages. This effect was found to be greater for the longer reading passages followed by a greater number of questions to be answered.

Ludlam WM Twaroski C Ludlam DP
"Optometric visual training for reading disability. A case report." *Am J Optom Arch Am Acad Optom* 1973 Jan;**50**(1):58-66

Mann I
"Perceptual training: misdirections and redirections. *Am J Orthopsychiat* 1970;**40**(1):30-8

Marks HB
"Evaluation of visual perceptual training for reading disabilities. *RI Med J* 1970;**50**(3):150-1,162

McCormick CC Schnobrich JN Footlik SW et al.
"Improvement in reading achievement through perceptual-motor training." *Research Qtly* 1968 Oct:23-33

Forty-two underachieving grade I children matched for age, sex, IQ, and Lee-Clark reading grade level were randomly assigned to one of three

groups. One group received perceptual-motor training, the second received exercises from the regular physical education curriculum, and the third group served as a control. After seven weeks of training (two periods a week) reading achievement was reassessed. The experimental group was found to have made statistically significant gains, while the other two groups had made no such gains.

McCormick CC Schnobrich JN Footlik SW et al.
"The effect of perceptual-motor training on reading achievement." *Acad Ther* 1969;**4**(3):171-6

Morrison D Sublett J
"The effects of sensory integration therapy on nystagmus duration, equilibrium reactions and visual-motor integration in reading retarded children." *Child Care Health Dev* 1986 Mar-Apr;**12**(2):99-110

Previous research on the effects of sensory integration therapy on vestibular processing dysfunction has not used an appropriate control group design. Using a control group, this research investigated the effects of sensory integration therapy on nystagmus duration, equilibrium reactions and visual-motor integration in 26 children with reading retardation. The sample had average intelligence but showed depressed nystagmus duration, problems in equilibrium reactions and delays in visual-motor coordination. Sixty-six sessions of therapy did not significantly affect duration, equilibrium or visual-motor integration.

Sohrab-Jam G
"Eye movement patterns and reading performance in poor readers: immediate effects of convex lenses indicated by book retinoscopy." *Am J Optom Physiol Opt* 1976 Nov;**53**(11):720-6

Eye movement patterns and reading performance were evaluated in 38 4th and 5th grade male students who were at least 1 year behind in their reading levels. Half of the subjects (Group I) demonstrated a need for convex lenses at near by a book retinscopy criterion. The remaining subjects (Group II) showed no need for convex lenses at near by the same criterion. The subject's eye movements during reading were recorded by a commercial device called Eye-Trac. These recordings were made with 2 lens applications, plano and +0.50 D, respectively. The number of fixations, regressions, rate of reading, and relative efficiency for each condition (plano and +0.50 D) were calculated. In Group I, 3 of 5 measures showed significant improvement with plus lenses. These subjects showed fewer regressions, increased reading speed, and higher relative efficiency with plus than without. In Group II, 3 of 5 measures showed decrement with plus lenses, while 1 (comprehension) showed improvement. These subjects showed more fixations and regressions and lower relative efficiency with plus than without. It is therefore concluded that convex lenses of low power can have considerable immediate effect on children's reading skills, sometimes helpful and sometimes detrimental, and that proper pretesting with book retinoscopy will aid in the prediction of this effect.

Solan HA
"Visual processing training with a tachistoscope: a rationale and grade one norms." *J Learn Disabil* 1969;**2**:30-7

Diagnostic testing in kindergarten and the primary grades of children who are experiencing learning disabilities has revealed certain consistent perceptual deficiencies. Among these are poor figure ground relationships, poorly developed perceptual form constancy, inadequate spatial and directional relationships, immature visual motor development and finally, poor short term visual memory as measured with a tachistoscope. It is the purpose of this paper to establish a set of expected tachistoscopic responses using three digits at 0.1 and 0.01 seconds for children in the sixth month of grade one whose average age is six years, five months. Using a sample of 250 children, the mean, the median scores and a percentile scale have been developed so that a child in grades one, two or three who

is experiencing a perceptual deficit can be compared to the grade one child. The coefficient of correlations between success in reading and tachistoscopic response at each speed has been calculated.

Stebbins AL
"The significance of visual training in the treatment of reading disabilities." *Kansas Optom J* 1982 May;**50**(3):16

Wildsoet CF Foo KH
"Reading performance and low plus lenses." *Clin Exper Optom* 1988 May; **71**(3):100-5

Low plus lenses are used extensively by functional optometrists to treat near point stress and associated reading problems. However there have been few attempts to quantify the effects of these lenses on performance in controlled experiments. In the current study, reading performance of 13 children who had been wearing low plus lenses was assessed with a Biometric Eye-Trac Recorder through both plano lenses and lenses matching the children's prescriptions. All children had worn their low plus prescriptions for between six and 15 months. We found no statistically significant difference in reading performance measured through the low plus lenses and plano lenses, for the four parameters examined ie. reading speed, frequencies of fixations and regressions, and comprehension. A number of alternative explanations for these results are explored, including the possibility of a positive placebo effect.

LEARNING DISORDERS

Atzmon D
"Positive effect of improving relative fusional vergence on reading and learning disabilities." *Binoc Vis* 1985 Oct;**1**(1):39

> Following ten years of treating children with reading disabilities by orthoptic exercises, the author believes that the cause of some of these problems may be lack of sufficient relative fusional vergences. All children who were treated had had previous reading courses without satisfactory results. However, when fusional vergences reached "optimal" levels, marked progress in reading occured. The author strived for absolute convergence of 60 prism diopters and relative convergence of 30 prism diopters at distance and near, and divergence of 15 prism diopters. Almost all children complained of asthenopia. 150 children ages 4 to 18 were selected at random out of about 800. Followup time was 6 weeks to five years. 66% had exophoria, 7% had esophoria and 27% had orthophoria. In many cases absolute convergence of 40 prism diopters seemed sufficient at near, but at 6m there was convergence of 4-6 prism diopters only. In other cases relative amplitudes were low, and when they improved - performance in reading improved. Of 109 children who finished treatment, 15% reported little or no improvement in one or more aspects at school. But 85% reported improvement in one or more aspects at school: reading, concentration, spelling, handwriting and copying from the blackboard.

Hammer L Shimada L
"Teacher awareness of the role of vision therapy in a learning problem child." Optometric Extension Program 1987 Jul;**59**(10):537

Heiger AA
"Vision training and learning disorders." *Conn Med* 1984 Dec;**48**(12):778-80

Keogh BK
"Optometric vision training programs for children with learning disabilities: review of issues and research." *J Learn Disab* 1974;**7**:219-31

> This paper is a comprehensive review of the professional research literature on the effects of using vision training programs to enhance readiness skills of children entering school and for remediation of learning problems of children already in school. Focusing on the optometric developmental vision training programs, the author reviews background and assumptions, techniques and procedures, evidence relevant to program effectiveness, and issues, questions, and criticisms. It is concluded that confounding of sampling, program procedures, and research methodology make existing evidence too limited for a decision on the program effects. A definitive statement as to efficacy of developmental vision training awaits delineation to the nature of the interaction between child characteristics and program characteristics - that is, what aspects of the programs are effective for what children?

Laudon RC
"Optometric evaluation and therapy for the learning disabled child." *Contemporary Optometry* 1986 Aug;**5**(3):25.*S Afr Optom* 1988 Jun;**47**(2):43

Punnett AF Steinhauer GD
"Relationship between reinforcement and eye movements during ocular motor training with learning disabled children." *J Learn Disabil* 1984;**17**:16-9

Four reading disabled childen were given eight sessions of ocular motor training with reinforcement and eight sessions without reinforcement. Two reading disabled control Ss were treated similarly but received no ocular motor training. Results demonstrated that reinforrcement can improve ocular motor skills, which in turn elevates reading performance.

Rubin A
"Visual therapy and learning disability." *S Afr Med J* 1987 Sep;72(6):373-5

Seiderman AS
"Optometric vision therapy -- results of a demonstration project with a learning disabled population." *J Am Optom Assoc* 1980 May;**51**(5):489-93

Thirty-six children attending a private school for learning disabled children were diagnosed as having visual and/or perceptual disorders. The experimental group received individual programming in visual and perceptual development at their appropriate developmental levels. The control group received instruction in physical education, art or music classes. Both groups received individualized reading assistance. Statistical analysis of the two year demonstration project, which included nine months of actual training, indicated that the experimental group made significant gains in reading as compared to the control group. The improvement in basic instructional level of The Informal Reading Inventory (Temple University), and the Word Reading and Paragraph Meaning subtests of the Stanford Achievement Tests, and the actual classroom reading levels were all statistically significant. The Informal Word Recognition Inventory (Daniels) and the Spelling subtest of the Stanford Achievement Tests showed a definite trend approaching statistical significance.

Swanson WL
"Optometric vision therapy: How successful is it in the treatment of learning disorders?" *J Learn Disab* 1972;**5**:285-90

Records of 100 consecutive cases of learning disorders which were treated in my practice by optometric vision therapy were examined for 46 different items of interest. Following are some of the questions for which answers were sought: What is the percentage of treatment success? How many were far-sighted? How many were near-sighted? How many had astigmatism? How many had dyslexia? What were the ages? Significant improvement in learning ability was recorded in over 90% of the cases. The statistics also revealed the inadequacy of the Snellen Chart for testing the vision of a person with learning disorders.

LATERALITY/REVERSAL PROBLEMS

Greenspan SB
"Effectiveness of therapy for children's reversal confusions." *Acad Therapy* 1975-76 Winter;**11**(2):169-178

Two groups of underachievers (26 children each), matched for personal variables, aspect of therapy, and reversal tendencis, were given either percetual-motor training (involving gross and fine motor skills, attention to spatial directionality, and form perception) or orthoptic visual training. The perceptual-motor training group showed significant improvement (decreased reversals) as measured by some of the tests used.

Hill SD McCullum AH Sceau AG
"Relationship of training in motor activity to development of right-left directionality in mentally retarded children: an exploratory study." *Percept Mot Skills* 1967(24):363-6

The effect of a systematic program of exercises on the development of retarded children's awareness of right-left directionality was studied. The children were oriented toward observing the use of specific body parts and directed to select willfully a specified body part in making a response. Half of the children were required to also use a directional verbal label for the body part used. Those who did not use directrional verbal labels showed as much improvement as those who did. These findings suggest that the lag in development of a concept of right-left awareness found with these retarded children was not due to a deficit in verbalization per se.

DYSLEXIA

Haddad HM Isaacs NS Onghena K et al.
"The use of orthoptics in dyslexia." *J Learn Disab* 1984 Mar;**17**(3):142-4

In 73 children (6-13 years old) with reading difficulty, ophthalmological evaluation showed that 18 had overt refractive errors, 18 dyslexia and no ocular anomalies, and 37 impaired fusional amplitudes, 24 of whom were dyslexic. In all cases with poor fusional amplitudes the reading mechanism could be improved with orthoptic exercises.

Hall DM
"Monocular occlusion in dyslexic children." *Lancet* 1985 Sep;**2**(8457P):728

Stein J
"Effect of monocular occlusion on visuomotor perception and reading in dyslexic children." *Lancet* 1985 Jul;**2**(8446P):69

PERCEPTUAL & SENSORY INTEGRATION TRAINING

Ball K Sekuler R
"Improving visual perception in older observers." *J Gerentology* 1986 Mar; **41**(2):176

> Younger observers (M = 21 years) proved to be better then older observers (M = 68 years) at discriminating one direction of motion from another, highly similar one. Several days' practice steadily improved performance for both groups equally. Improvement was well restricted to the direction with which that observer practiced, and the full gains were retained for at least 1 month. Control measurements with various degrees of optical blur demonstrate that direction discrimination does not require a well-focused retinal image. This rules out optical factors as the potential cause of the prepractice differences between groups.

Belmont L Flegenheimer H Birch HG
"Comparison of perceptual training and remedial instruction for poor beginning readers." *J Learn Disab* 1973 Apr;**6**(4):230-5

> Two matched groups of beginning readers with equivalent degrees of risk for reading failure were provided, respectively, with sup-plementary perceptual training or remedial instuction using letters and words, in addition to receiving regular first grade classroon insruction. After 7 months of sup-plementary instruction, both groups had made equivalent advances in reading level, indicating that neither perceptual training nor remedial reading was the superior program.

Bieger E
"Effectiveness of visual perceptual training on reading skills of non readers, an experimental study." *Percept Mot Skills* 1974;**38**:1147-53

> 48 second and third grade non-readers who were estimated to have perceptual deficiencies were randomly placed in experimental and control groups. The experimental group received perceptual training plus remedial instruction. The control group received only remedial instruction. After 7 months, the low perceivers given visual training improved significantly in visual perception, but improvements were not reflected in reading achievement. Controls gained 8 mo. in reading achievement versus 6 mo. for experimentals, indicating that perceptual training did not influence the achievement of reading skills for this group.

Breslaurer AH Mack JD Wilson WK
"A perceptual training program." *Acad Therapy* 1976 Spring:321-324

Carlson PV Greenspoon MD
"The uses and abuses of visual training for children with perceptual-motor learning problems." *Am J Optom Assoc* 1968;**45**(3):161-9

Clark DM Dodd BE
"Auditory factor in visual-motor testing and training." *J Learn Disab* 1971 Dec;**4**(10):582-5

Cohen RI
"Remedial training of first grade children with visual perceptual retardation." *Educ Horizons* 1966;**45**:60-3

Early GH Sharpe TM
"Perceptual-motor training and basic abilities." *Acad Ther* 1970; 5(3):235-40

Edger CL et al.
"Effects of sensori-motor training on adaptive behavior." *J Ment Defic Res* 1969;**73**:713-20

Falik LH
"The effects of special perceptual-motor training in kindergarten on reading readiness and second grade performance." *J Learn Disab* 1969; **2**(8):10-7

Farr J Leibowitz HW
"An experimental study of the efficacy of perceptual-motor training." *Am J Optom Physiol Opt* 1976 Sep;**53**(9):451-5

The efficacy of 40 h of perceptual-motor training among a group of culturally disadvantaged kindergarten children was investigated. The training procedures produced a significant improvement in perceptual-motor abilities such that each group was raised to a "non-dysfunctioning" level as evaluated by the Rosner-Richman Perceptual Motor Survey. In terms of the design of this study, the effects observed and the differences obtained cannot be attributed either to maturation or to attendance in school per se.

Footlik SW
"Perceptual-motor training and cognitive achievement: a survey of the literature." *J Learn Disab* 1970;**3**(1):40-9

Friedman HN
"An optometric visual perceptual program." *J Am Optom Assoc* 1968; **39**(1):61-3

Gage J Workman S Burgess W
"Effect of sensory integration, vision, and memory training on older adults. Research Reports and Special Articles." *Optometric Extension Program* 1988 Dec;**61**(3):109

Gauthier GM Hofferer JM
"Visual motor rehabilitation in children with cerebral palsy." *Int Rehabil Med* 1983;**5**(3):118-27

Cerebral palsied (CP) children were given intensive visuo-oculomotor training in order to improve their visuo-oculomotor control, using children's films as a visual stimulus. A comparative study was conducted on a group of normal children of the same age. Results showed that training does improve visuo-oculomotor system control as illustrated by (1) a marked increase in smooth pursuit precision and maximum velocity, (2) an improvement of saccadic movement precision and stability, and (3) a shortening of the saccadic reaction time. The highest performance was observed under conditions in which the child pointed at and followed the visuo-acoustic target with his arm extended.

Greenspan SB
"Effectiveness of therapy for children's reversal confusions." *Acad Therapy* 1975-76 Winter;**11**(2):169-178

Two groups of underachievers (26 children each), matched for personal variables, aspect of therapy, and reversal tendencis, were given either percetual-motor training (involving gross and fine motor skills, attention to spatial directionality, and form perception) or orthoptic visual training. The perceptual-motor training group showed significant improvement (decreased reversals) as measured by some of the tests used.

Greenspan SB
"Research studies of visual and perceptual-motor training." *Research Reports and Special Articles* Optometric Extension Program Oct 1971-Sep 1972;**44**(1-12):1

Groffman SG Press LJ
"Computerized perceptual therapy programs - Part I." *Research Reports and Special Articles* Optometric Extension Program 1989 Aug;**61**(11):387

Groffman SG Press LJ
"Computerized perceptual therapy programs - Part II." *Research Reports and Special Articles* Optometric Extension Program 1989 Sep;**61**(12):423

Halliwell JW Solan HA
"The effects of a supplemental perceptual training program on first grade reading achievement." *Except Child* 1972 Apr;**38**:613-22

Three matched groups of first graders were selected. One group received no special instruction, one group received special educational instruction, and the experimental group received perceptual-motor vision therapy. The experimental group achieved significantly superior performance on a standardized achievement test.

Hoffman LG
"The effect of accommodative deficiencies on the developmental level of perceptual skills." *Am J Optom Physiol Opt* 1982 Mar;**59**(3):254-62

The relation of accommodative to visual-motor perceptual abilities was investagated. Patients between 5 and 13 years of age manifesting both accommodative and visual-motor perceptual deficits were given accommodative therapy. The effect of this therapy was analyzed, and the results indicated that improvement in the visual and motor perceptual abilities occurred in the 5 to 7 years, 11 month age group.

Keim RP
"Visual-motor training, readiness, and intelligence of kindergarten children. *J Learn Disab* 1970;**3**(5):256-9

Krippner S
"On research in visual training and reading disability." *J Learn Disab* 1971;**4**(2):8-17

Linn S
"Achievement report of first-grade students after visual-perceptual training in kindergarten." *Ac Ther Qtly* 1968 Spring

Linn SH
"Visual perceptual training for kindergarten children." *Acad Ther* 1967; **2**(4):255-8

Lloyd B
"The effects of programmed perceptual training on the reading achievement and mental maturity of selected first grade pupils: A pilot study." *J Read Specialist* 1966;**6**:49-55

Loewndahl E
"See-sickness: Easily missed-but not by experts." *Amer Cor Therapy J* 1973 Nov;**27**(6);168-72

Describes the problem of and treatment for visual-perception handicaps such as deficiencies in fusion, focus flexibility, accommodation, and eye-hand

coordination. It is suggested that the conventional Snellen Test which assesses only distance vision does not tell anything about total vision or the ability to get meaning out of what is being seen. Visual therapy can improve such skills, and the visual training programs of optometrists are described. Case examples of both children and adults are provided.

Maino DM
"Microcomputer mediated visual developmental and perceptual therapy." *J Am Optom Assoc* 1985 Jan;**56**(1):45-8

There are currently few computer programs written by optometrists for optometrists to be utilized as methods of treatment for those patients with deficits in the areas of developmental vision and perception. This paper reviews educational and commercially available programs that with certain modifications may meet the therapeutic needs of our patients.

Maloney MF Ball TS Edgar IC
"Analysis of generalizability of sensori-motor training." *Am J Ment Defic* 1974;**74**:458-69

Mann I
"Perceptual training: misdirections and redirections. *Am J Orthopsychiat* 1970;**40**(1):30-8

Marks HB
"Evaluation of visual perceptual training for reading disabilities. *RI Med J* 1970;**50**(3):150-1,162

McCormick CC Schnobrich JN Footlik SW et al.
"Improvement in reading achievement through perceptual-motor training." *Research Qtly* 1968 Oct:23-33

Forty-two underachieving grade I children matched for age, sex, IQ, and Lee-Clark reading grade level were randomly assigned to one of three groups. One group received perceptual-motor training, the second received exercises from the regular physical education curriculum, and the third group served as a control. After seven weeks of training (two periods a week) reading achievement was reassessed. The experimental group was found to have made statistically significant gains, while the other two groups had made no such gains.

McKee GW
"The role of the optometrist in the development of perceptual and visuomotor skills in children." *Am J Optom Arch Am Acad Optom* 1967 May;**44**(5):297-310

McKee GW
"The Spring Branch Project and the Wainwright Project: optometric vision screening, visual-motor-perceptual screening, optometric vision therapy, and visuomotor-perceptual therapy with kindergarten, first and second grade children within a school setting." *Am J Optom Physiol Opt* 1974 Dec

Morrison D Sublett J
"The effects of sensory integration therapy on nystagmus duration, equilibrium reactions and visual-motor integration in reading retarded children." *Child Care Health Dev* 1986 Mar-Apr;**12**(2):99-110

Previous research on the effects of sensory integration therapy on vestibular processing dysfunction has not used an appropriate control group design. Using a control group, this research investigated the effects of sensory integration therapy on nystagmus duration, equilibrium reactions and visual-motor integration in 26 children with reading retardation. The

sample had average intelligence but showed depressed nystagmus duration, problems in equilibrium reactions and delays in visual-motor coordination. Sixty-six sessions of therapy did not significantly affect duration, equilibrium or visual-motor integration.

Pitcher-Baker G
"Does perceptual training improve reading?" *J Optom Vis Training* 1974; 5:40-5. Reprinted from Academic Therapy 1973 Fall;**9**:41-5

Podell SM
"The effectiveness of developmental training." *Optom Wkly* 1976 Sep **67**(40):1074-1076

An interesting clinical report comparing the results of standardized psychoeducational tests before and after developmental perceptual therapy.

Rosner J
"The development of a perceptual skills curriculum." *J Am Optom Assoc* 1973 Jul:698-707

Rosner J Rosner J
"The clinical management of perceptual skills disorders in a primary care practice." *Am J Opt Assoc* 1986 Jan;**57**(1):56-9

Shankman AL
"Vision enhancement training and mind-body philosophy." Optometric Extension Program Oct 1985-Sep 1986;**58**(1-12)

Solan HA Seiderman AS
"Case report on a grade one child before and after perceptual-motor training." *J Learn Disab* 1970;**3**:635-9

Cognitive development in the primary grades is dependent in part upon a child's ability to process information. A child who is experiencing a lag in neurological maturation and perceptual-motor development is less able to cope with the problems in learning at the primary level of education. This report illustrates a case in which early identification and treatment of perceptual-motor deficits enabled the child to respond to instruction more effectively.

Sullivan J
"The effects of Kephart's Perceptual-Motor Training on a reading clinic sample." *J Read Disab* 1972:545-51

Stein J
"Effect of monocular occlusion on visuomotor perception and reading in dyslexic children." *Lancet* 1985 Jul;**2**(8446P):69

Swartwout JB
"Symbol-sound association techniques." *Acad Therapy* 1973 Fall;**9**(1):61-70

Emphasizes the importance of optometrists in remediation of academic underachievement problems through visual training. Methods to supplement optometric vision therapy for remediation of symbol-sound asssociation problems are described and illustrations of the Forrest Visual Auditory-Verbal Program, the Experience Reader, the Neurological Impress method and the Apell(Trick) Reading method are included. Each method is briefly discussed on use and value to optometrists and educators in developing sound-symbol association.

Wilson WK Mack JD Breslauer AH
"The Coronado project: an identification and remediation visual perceptual training program." Optometric Extension Program Foundation 1975

CEREBRAL PALSY

Duckman RH
"Accommodation in cerebral palsy: function and remediation." *J Am Opt Assoc* 1984 Apr;**55**(4):281-3

> Accommodation function in a population oof severely involved cerebral palsied children, is significantly impaired or absent. This observation suggests that lowered amplitudes and accommodation facility could be part of the cerebral palsy syndrome and untrainable. This paper looks at the accommodative function and the results of vision training on such a population.

Duckman RH
"Effectiveness of visual training on a population of cerebral palsied children." *J Am Optom Assoc* 1980 Jun;**51**(6):607-14

> For years, researchers have recognized the very high incidence of visual anomalies in the population of children with cerebral palsy. However, little if anything has been attempted to remediate these problems. This article describes an experimental program of visual training, applied on a daily basis, to a population of in-patient, cerebral palsied children. After one year, the results were evaluated and the findings are discussed.

Duckman RH
"Vision therapy for the child with cerebral palsy." *J Am Optom Assoc* 1987 Jan;**58**(1):28-35

> There has been an abundance of data collected on the high prevalence of visual anomalies in cerebral palsy. Relatively little has been written about remediation. This article discusses the problems encountered in the CP population, and therapy programs which can be utilized to deal with them. Heavy emphasis is placed on ocular motility and accommodation because deficits in these two visual skills are encountered very frequently, are most amenable to therapy, and show the greatest improvement as a result of vision therapy.

Gauthier GM Hofferer JM
"Visual motor rehabilitation in children with cerebral palsy." *Int Rehabil* Med 1983;**5**(3):118-27

> Cerebral palsied (CP) children were given intensive visuo-oculomotor training in order to improve their visuo-oculomotor control, using children's films as a visual stimulus. A comparative study was conducted on a group of normal children of the same age. Results showed that training does improve visuo-oculomotor system control as illustrated by (1) a marked increase in smooth pursuit precision and maximum velocity, (2) an improvement of saccadic movement precision and stability, and (3) a shortening of the saccadic reaction time. The highest performance was observed under conditions in which the child pointed at and followed the visuo-acoustic target with his arm extended.

Hiles DA
"Results of strabismus therapy in cerebral palsied children." *Am Orthopt J* 1975;(25):46-53

MOTION SICKNESS

Gillilan RW
"Visual adjustment said key to motion sickness therapy." *Optom Times* 1983 Oct;**1**(1):32

Gillilan RW Todd D
"Vision therapy as a treatment for motion sickness." *J Am Optom Assoc* 1986 Jun;**57**(6):456-458

PRISM APPLICATIONS

Berard PV
"Prisms; their therapeutic use in the child." *J of Ped Ophthal* 1968;**5**: 53-63

The author discusses the value of the use of prisms in the treatment of disorders of binocular vision in the child. Prisms may be used to facilitate or permit bifoveal vision and to modify the abnormal sensory state.

Birnbaum MH
"Adverse response to prism therapy in strabismus." *J Am Optom Assoc* 1976 Sep;**47**(9):1195-9

The recent literature on prism therapy in strabismus is reviewed. A case is reported in which an esotrope, treated by means of prism neutralization to effect sensory orthotropia, responded with a marked increase in the angle of squint. Guidelines are suggested to minimize risk of such adverse effect when prism therapy is attempted.

Christenson GN Rouse MW
"Management of a young esotrope using vision therapy and prismatic prescription." *J Am Optom Assoc* 1987 Jul;**58**(7):592-6

This case report illustrates the important issues concerning optometric management of the pediatric patient presenting with esotropia. Appropriate treatment options and prognostic factors are covered. The case demonstrates the successful, sequential treatment of a young, early-onset, esotropic patient through vision therapy and prismatic lens prescription.

Greenwald I
"Reverse prism in the treatment of strabismus." *J Opt Vis Dev* 1975 Jun; **6**(2):43-7

The article describes a technique which utilizes overcorrecting prisms as a means of creating an immediate disruption of sensory-motor adaptation in the anomalous corresponder. In addition, a discussion of the phenomenon of passive rotation of the strabismic eye and its application to the reverse prism technique is included.

Iacobucci T Beyst-Martonyi J
"The use of press-on prisms in the preoperative evaluation of adults with strabismus." *Am Orthopt J* 1978;**28**:68-70

Moore S Stockbridge L
"An evaluation of the use of Fresnel press-on prisms in childhood strabismus." *Am Orthopt J* 1975;**25**:62-6

Moore S Stockbridge L
"Fresnel prisms in the management of combined horizontal and vertical strabismus." 1972;**22**:14-21

Fresnel prisms were prescribed first for only the horizontal component of patients with combined vertical and horizontal strabismus. If the vertical deviation is not eliminated and bifoveal fixation is not present, the prisms are reapplied in an oblique manner so that both the horizontal and vertical components of the strabismus are compensated. The Fresnel prisms were found to be helpful in eliminating diplopia in the visually mature patient and as a temporary measure for certain patients requiring surgery.

Pigassou-Albouy R
"A discussion of prism therapy for strabismus." *J Ophthalmic Nurs Technol* 1988 Jan-Feb;**7**(1):18-25

Reinecke RD Simons K Moss A et al.
"An improved method of fitting resultant prism in treatment of two-axis strabismus." *Arch Ophthal* 1977 Jul;**95**(7):1255-7

A new chart determines resultant prism power and angle when correction of combined horizontal and vertical deviation with a single prism, set at an angle intermediate between horizontal and vertical, is desired. The chart is based on a derivation so weighted as never to permit a vertical error greater than one tenth as large as the associated horizontal error, with use of commercially available sizes of plastic Fresnel-type prisms. This weighting takes into account differences in horizontal and vertical fusional reserves. A compass rose facilitates proper alignment of the prisms.

Veronneau-Troutman S
"Fresnel prism membrane in the treatment of strabismus." *Can J Ophthal* 1971 Oct;**6**(4):249-57

Veronneau-Troutman S
"Fresnel prism membrane in acquired extraocular muscle palsy." *Am Orthopt J* 1974;**24**:91-7

Veronneau-Troutman S
"Fresnel prisms and their effects on visual acuity and binocularity." *Trans Am Ophthal Soc* 1978;**76**:610-53

1. The visual acuity with the Fresnel membrane prism is significantly less than that with the conventional prism of the same power for all prism powers from 12 delta through 30 delta at distance and from 15 delta through 30 delta at near. 2. The difference in the visual acuity between base up and base down, and between base in and base out, is not significantly different for either the Fresnel membrane prism or for the conventional prism. 3. For both Fresnel membrane prism and the conventional prism, the visual acuity when looking straight ahead. 4. Using Fresnel membrane prisms of the same power from different lots, the visual acuity varied significantly. The 30 delta prism caused the widest range in visual acuity. 5. When normal subjects are fitted with the higher powers of the Fresnel membrane prism, fusion and stereopsis are disrupted to such an extent that the use of this device to restore or to improve binocular vision in cases with large-angle deviations is seriously questioned. 6. Moreover, the disruption of fusion and stereopsis is abrupt and severe and does not parallel the decrease in visual acuity. The severely reduced ability to maintain fusion may be related to the optical aberrations, which, in turn, may be due to the molding process and the polyvinyl chloride molding material. 7. Through the flexibility of the membrane prism is a definite advantage, because of its proclivity to reduce visual acuity and increase aberrations its prescription for adults often must be limited to only one eye. 8. For the same reasons in the young child with binocular vision problems, the membrane prism presently available should be prescribed over both eyes only in powers less than 20 delta. When the membrane prism is to be used as a partial occluder (over one eye only), any power can be used. 9. The new Fresnel "hard" prism reduces visual acuity minimally and rarely disrupts binocularity, thus increasing the potential for prismo-therapy to establish binocularity. This prism is currently available only for use as a trial set. Since the cosmetic appearance of the Fresnel "hard" prism is similar to that of the Fresnel membrane prism and it is easier to maintain, it would be the prism of choice (over all other types) for bilateral prescriptions in the young patient with emmetropia. The manufacturer is urged to make these prisms available to fit a special round adjustable frame, such as that developed in Europe for use with the wafer prism.

Veronneau-Troutman S
"Fresnel prism membrane in the treatment of strabismus." *Can J Ophthal* 1971 Oct;**6**(4):249-57

Veronneau-Troutman S
"A new optical modality to overcome diplopia." *Trans Am Ophthal Soc* 1979;**77**:181-90

The author has presented a new method to correct vertical diplopia using a prism contact lens. To the present time, its application has been limited to contact lenses correcting refractive errors of less than 3D and to ground-in prisms of not more than 6 delta. The field is new. Technical, mathematical, and clinical advances should eventually allow the use of stronger prisms over a wider range of refractive corrections.

OCCLUSION/PENALIZATION

Berard PV Layec-Arnail M
"Penalization in strabismus." *Int Ophthal* 1983 Jan;**6**(1):13-8

Penalization includes all those methods apart from total occlusion which disturb the central vision of one eye by favouring the other eye. Penalization has a sensory action on functional amblyopia; moreover it also has a motor action, influencing the non-accommodative element of spasm in esotropia. Optical penalization is the most classical method. However, one should also be aware of penalization with partial occlusion or fogging, penalization with mydriatics, and penalization with sectors, which are very often used in association with the classical technique.

Charman WN
"Optical characteristics of Transpaseal as a partial occluder." *Am J Optom Physiol Opt* 1983 Oct;**60**(10):846-50

The acuity degradation produced by Transpaseal, a typical adhesive scattering material applied to spectacle lenses to produce partial occlusion during orthoptic treatment, is studied by measuring the angular characteristics of the scattering and its effect upon the visual contrast sensitivity function. Whereas in general the material acts as a low-pass spatial frequency filter, it is shown that the scattering function is not symmetrical and hence that the visual degradation produced varies with the orientation of the detail observed.

Chutter CP
"Occlusion treatment of intermittent divergent strabismus." *Am Orthopt J* 1977;**27**:80-4

Cibis L
"Penalization, treatment of ARC and amblyopia." *Am Orthopt J* 1975; **25**:79-84

Dalziel CC
"Strabismic amblyopia." *Am J Optom Physiol Opt* 1981 Sep;**58**(9):777-9

A 5-year-old male strabismic amblyope whose initial visual acuity in his amblyopic right eye was 6/30 (20/100) achieved a level of 6/6 (20/20) after 8 weeks of occasional occlusion therapy of the nonamblyopic eye.

Elmer J Fahmy YA Nyholm M Norskov K
"Extended wear soft contact lenses in the treatment of strabismic amblyopia." *Acta Ophthal* (Copenh) 1981 Aug;**59**(4):546-51

17 amblyopic children between 4 and 9 years were fitted with high power plus extended wear soft contact lenses (Scanlens 24 h, Duragel 75) for optical occlusion of strabismic amblyopia. Amblyopia and eccentric fixation responded quickly to treatment between 2 to 13 weeks. Only one patient failed to reach 6/9, and 11 patients achieved equal visual acuity. Out of 10 patients with eccentric fixation only two remained eccentric after treatment. The contact lenses were tolerated by the children. Among the problems, concerning the use of extended wear soft contact lenses, should be mentioned fitting problems, deposits, loss of lenses (1 child needed 4 lenses) and occurrence of conjunctivitis (5 eyes). No major infections were seen. A one year followup showed that almost all the children needed renewed occlusion treatment. It is therefore recommended to continue with contact lens occlusion for at total period of 3 months.

Fletcher MC Abbott W Girard LJ et al.
"Biostatistical studies. Results of biostatistical study of the management of suppression amblyopia by intensive pleoptics versus conventional patching." *Am Orthopt J* 1969;**19**:8-30

Fletcher MC Silverman SJ Boyd J et al.
"Biostatistical studies. Comparison of the management of suppression amblyopia by conventional patching, intensive hospital pleoptics, and intermittent office pleoptics." *Am Orthopt J* 1969;**19**:40-7

Goodier H
"Some results of conventional occlusion." *Br Orthop J* 1974;**31**:55-8

The purpose of this paper was to analyze the results of conventional occlusion in cases of non-central fixation. Fifty patients between the ages of 6 months and 10 years were studied. Ninety-two percent of those studies were treated solely with conventional occlusion and the remaining patients received inverse occlusion as well as some conventional occlusion. Conventional (direct) occlusion appears to be effective in the treatment of amblyopia in cases of noncentral fixation in 95% of the cases reviewed in this study. The patients having had inverse occlusion at some stage in the treatment showed a 50% success rate. Anisometropes showed a quicker response to occlusion than did those patients who had an equal refractive error associated with the squint. Visual acuity improved rapidly in the majority of cases within three months with conventional occlusion. Inverse occlusion may require a longer time period in which the patient must undergo occlusion than would be needed with conventional occlusion.

Gregersen E
"Occlusion treatment of squint amblyopia in young adults." *Acta Ophthal* 1966;**44**:166-8

Gregersen E Rindziunski E
"Conventional occlusion in the treatment of squint amblyopia." *Acta Ophthal* 1965;**43**:462-74

Kirschen D Flom MC
"Monocular central-field occlusion for intractable diplopia." *Am J Optom Physiol Opt* 1977 May;**54**(5):325-31

This report describes several methods of degrading imagery through the central portion of a spectacle lens to provide a cosmetically acceptable means of obtaining single vision in the central field of patients with intractable diplopia. For 2 strabismic patients with annoying diplopia, we applied to 1 spectacle lens a centrally placed disc (about 1 inch diameter) consisting of (1) translucent tap,a (2) a +7 D Fresnel lens,b or (3) stippled, clear lacquer. For 1 patient, the lacquer was the most acceptable; for the other, the tape was best. We present here the case reports for these 2 patients, showing why they preferred different image-degrading methods and how these and other methods of central-field image degrading can be advantageous even when diplopia is present across most of the visual field.

Malik SR Virdi PS Goel BK
"Follow-up results of occlusion and pleoptic treatment." *Acta Ophthal* (Copenh) 1975 Sep;**53**(4):620-6

Fifty cases of amblyopia, including some cases of eccentric fixation, which had previously been successfully treated by various therapies (conventional occlusion, red filter occlusion and pleoptics) were followed up from 12 to 68 months. Fifteen cases (30%) deteriorated to pretreatment level during the follow up. Deterioration was found to be greater in cases over the age

of 15 years and in cases who did not follow the instructions given to them after cessation of therapy.

Massie H
"Fixing eye occlusion: survey of approximately 1000 case histories of patients who received occlusion of the fixing eye." *Trans Ophthal Soc Aust* 1965;**24**:39-46

McKenney S Byers M
"Aspects and results of penalization treatment." *Am Orthopt J* 1975;**25**: 85-9

Niederecker O Scott W
"The value of diagnostic occlusion for intermittent exotropia." *Am Orthopt J* 1975;**25**:88-91

It was found that the horizontal distance deviation in the primary position showed no significant difference between 24-hour and 45-minute occlusion. Sixty percent of patients with intermittent exotropia will have 2-10 degrees increase in distance deviation following 45-minute occlusion, there is a further increase of 5-7 degrees following five-day occlusion.

Singha JN
"Penalisation therapy in a residual concomitant convergent squint--a case report." *Ind J Ophthal* 1981 Dec;**29**(4):425-6

Vishnoi SK Singh V Mehra MK
"Role of occlusion in treatment of intermittent exotropia." *Ind J Ophthal* 1987 Jul-Aug;**35**(4):207-10

Veronneau-Troutman S Dayanoff SS Stohler T et al.
"Conventional occlusion vs. pleoptics in the treatment of amblyopia." *Am J Ophthal* 1974 Jul;**78**(1):117-20

AFTER-IMAGE - GENERAL

Fletcher MC Abbott W Girard LJ et al.
"Biostatistical studies. Results of biostatistical study of the management of suppression amblyopia by intensive pleoptics versus conventional patching." *Am Orthopt J* 1969;**19**:8-30

Fletcher MC Silverman SJ Boyd J et al.
"Biostatistical studies. Comparison of the management of suppression amblyopia by conventional patching, intensive hospital pleoptics, and intermittent office pleoptics." *Am Orthopt J* 1969;**19**:40-7

Flynn JT
"Results with the use of pleoptics in the treatment of amblyopia." *South Med J* 1968 Nov;**61**(11):1169-71

Griffin JR
"Comments on a novel method of detection of anomalous retinal correspondence." *Opt Mthy* 1980 Jun:45-7.

Porter's retinoscopic technique was tested and is compared with the Hering-Bielschowsky afterimage test for detecton of anomalous correspondence.

Isutsui J
"Improvement of visual acuity by amobarbital combined with pleoptics." *Am J Ophthal* 1966 Dec;**62**(6):1171-6

Jenkins TC Pickwell LD Sheridan M
"After-image transfer--evaluation of short-term treatment." *Br J Physiol Opt* 1979;**33**(2):33-7

The records of treatment by the after-image transfer method of 21 children, mainly with strabismus amblyopia, were examined to evaluate the acuity improvement in the short term. There was no significant improvement in 15 cases. In several other patients, an immediate response to the after-image method occurred, but these patients' binocular vision and acuity had deteriorated following previous improvement achieved by other orthoptic methods.

Koskela PU Hyvarinen L
"Contrast sensitivity in amblyopia III. Effect of occlusion." *Acta Ophthal* 1986 Aug;**64**(4):386-90

Contrast sensitivity of 26 children (mean age 9 years) was measured using vertical gratings during the course of pleoptic treatment. A statistically highly significant improvement in the vision of amblyopic eyes occurred during intensive treatment in the hospital. Occlusion of the amblyopic eye (inverse occlusion) before the pleoptic treatment did not effect the function of the amblyopic eyes. During 8-week occlusion of the dominant eye (direct occlusion) after pleoptic treatment changes in the vision of the amblyopic eyes were statistically insignificant. In some patients there was change in contrast sensitivity without a corresponding change in visual acuity. The contrast sensitivity of the dominant eye decreased markedly during occlusion in 12 patients. After a continuous occlusion of only 2 weeks there was a statistically significant decrease at spatial frequency 6 c/deg. There was no simultaneous decrease of visual acuity; thus the change can be called 'hidden occlusion amblyopia'. An additional 8-week occlusion did not cause any statistically significant decrease in contrast sensitivity, but visual acuity of 2 patients decreased slightly, a sign of beginning occlusion amblyopia. The changes disappeared during 'Einschleich'-occlusion or penalization except in one child whose previously dominant eye became non-dominant and slightly amblyopic.

Malik SR Virdi PS Goel BK
"Follow-up results of occlusion and pleoptic treatment." *Acta Ophthal* (Copenh) 1975 Sep;**53**(4):620-6

Fifty cases of amblyopia, including some cases of eccentric fixation, which had previously been successfully treated by various therapies (conventional occlusion, red filter occlusion and pleoptics) were followed up from 12 to 68 months. Fifteen cases (30%) deteriorated to pretreatment level during the follow up. Deterioration was found to be greater in cases over the age of 15 years and in cases who did not follow the instructions given to them after cessation of therapy.

Sen DK
"Results of treatment of anisohypermetropic amblyopia without strabismus." *Br J Ophthalmol* 1982 Oct;**66**(10):680-4

One hundred and two patients with anisohypermetropic amblyopia without strabismus were studied. Microstrabismus was excluded by detailed orthoptic examinations including visuoscopy and Cuppers' bifoveal correspondence test. Treatment consisted in wearing correcting glasses and parttime or fulltime patching of the nonamblyopic eye. In patients with dense amblyopia patching of the amblyopic eye was done and Cuppers' afterimage method of pleoptic therapy was instituted as the initial procedure. When visual acuity improved sufficiently by this therapy, patching was used on the nonamblyopic eye. Sixty-five (63.7%) patients showed 2 lines or more improvement on the Snellen chart. Though young children (6 to 12 years) improved their visual acuity more often than those aged 13 to 20 years, a considerable number of patients (50.0%) in the older age group improved their visual acuity after therapy. The improvement in visual acuity was accompanied by improved stereoacuity in 49.0% of the patients. It is therefore suggested that every effort should be made to treat these patients even after the age of 12 years.

Veronneau-Troutman S Dayanoff SS Stohler T et al.
"Conventional occlusion vs. pleoptics in the treatment of amblyopia." *Am J Ophthal* 1974 Jul;**78**(1):117-20

Wick B
"A home pleoptic method." *Am J Optom Physiol Opt* 1976 Feb;**53**(2):81-4

A method of initiating an after-image in an amblyopic eye with eccentric fixation by using Haidinger's brush for fixation control is described. This technique makes home pleoptics possible.

Jenkins TC Pickwell LD Sheridan M
"After-image transfer--evaluation of short-term treatment." *Br J Physiol Opt* 1979;**33**(2):33-7

The records of treatment by the after-image transfer method of 21 children, mainly with strabismus amblyopia, were examined to evaluate the acuity improvement in the short term. There was no significant improvement in 15 cases. In several other patients, an immediate response to the after-image method occurred, but these patients' binocular vision and acuity had deteriorated following previous improvement achieved by other orthoptic methods.

Wick B
"Anomalous after-image transfer--an analysis and suggested method of elimination." *Am J Optom Physiol Opt* 1974 Nov;**51**(11):862-71

PLEOPTICS

Amigo G
"Present trends in orthoptics and pleoptics in Giessen." *Am J Optom Arch Am Acad Optom* 1970 Sep;**47**(9):709-14

Cowan LJ Bennett MM Ogg DK
"Diagnostic and therapeutic uses of filters in orthoptics and pleoptics." *Am Orthopt J* 1966;**16**:24-9

Fletcher MC Abbott W Girard LJ et al.
"Biostatistical studies. Results of biostatistical study of the management of suppression amblyopia by intensive pleoptics versus conventional patching." *Am Orthopt J* 1969;**19**:8-30

Fletcher MC Silverman SJ Boyd J et al.
"Biostatistical studies. Comparison of the management of suppression amblyopia by conventional patching, intensive hospital pleoptics, and intermittent office pleoptics." *Am Orthopt J* 1969;**19**:40-7

Flynn JT
"Results with the use of pleoptics in the treatment of amblyopia." *South Med J* 1968 Nov;**61**(11):1169-71

Isutsui J
"Improvement of visual acuity by amobarbital combined with pleoptics." *Am J Ophthal* 1966 Dec;**62**(6):1171-6

Jablonski M Tomlinson E
"A new look at pleoptics." *Ophthalmology* 1979 Dec;**86**(12):2112-4

> Sixty-four patients who did not respond adequately to passive conventional occlusion were treated with active pleoptic therapy, and followed with orthoptic therapy when fusion potential was demonstrated. Patients ranged in age from 4 to 17 years, and ranged in visual acuity from 20/30 to 20/100. Seventeen patients had some fusion prior to starting pleoptics. All 64 patients achieved an immediate post-therapy acuity of 20/30 or better; 25 were fusing and demonstrated some stereopsis. Twenty-seven patients were followed for a period of one to ten years, including the 25 patients who were fusing at completion of therapy. Twenty-four (88%) maintained visual acuity of 20/30 or better. All fused either normally or with ARC. Three patients, whose visual acuity dropped to 20/50, had no fusion. Only one patient who had fusion at the completion of therapy was unable to maintain it. We conclude, therefore, that pleoptics retains values in the treatment of amblyopic patients with steady and unsteady central fixation, in those situations where conventional occlusion in unsuccessful.

Limpaecher E Apt L
"Prognosis in pleoptic therapy." *Am Orthopt J* 1974;**24**:42-6

Malik SR Virdi PS Goel BK
"Follow-up results of occlusion and pleoptic treatment." *Acta Ophthal* (Copenh) 1975 Sep;**53**(4):620-6

> Fifty cases of amblyopia, including some cases of eccentric fixation, which had previously been successfully treated by various therapies (conventional occlusion, red filter occlusion and pleoptics) were followed up from 12 to 68 months. Fifteen cases (30%) deteriorated to pretreatment level during the follow up. Deterioration was found to be greater in cases over the age of 15 years and in cases who did not follow the instructions given to them after cessation of therapy.

Nordman E
"Results of pleoptic treatment. Primary results of 412 patients and late results of 375 patients." *Acta Ophthal Suppl* 1972;**114**:3-88

Priestley BS
"Pleoptics--then and now." *Int Ophthal Clin* 1966 Fall;**6**(3):495-501

Rados WT Sellitto AM Angiuoli DN et al.
"Observations on outpatient pleoptics." *Am Orthopt J* 1966;**16**:111-27

Rinaldi SL
"Rinaldi-Larson dynascope: a new pleoptic and orthoptic instrument." *Am Orthopt J* 1967;**17**:88-92

Tomlinson E Jablonski M
"Results of modified pleoptic therapy in eccentric fixation." *Am Orthopt J* 1973;**23**:60-4

Tommila V Nordman E
"Late results of pleoptic treatment." *Br J Ophthal* 1969 Nov;**53**(11):769-72

Veronneau-Troutman S Dayanoff SS Stohler T Clahane AC
"Conventional occlusion vs. pleoptics in the treatment of amblyopia." *Am J Ophthal* 1974 Jul;**78**(1):117-20

Wick B
"A home pleoptic method." *Am J Optom Physiol Opt* 1976 Feb;**53**(2):81-4

A method of initiating an after-image in an amblyopic eye with eccentric fixation by using Haidinger's brush for fixation control is described. This technique makes home pleoptics possible.

Wick B
"Modified strobe flash for home pleoptics." *Am J Optom Physiol Opt* 1977 Mar;**54**(3):187-8

STRABISMUS-GENERAL

Birnbaum MH
"Management of intractable diplopia in small angle, non-fusing squint." *Am J Optom Physiol Opt* 1976 Aug;**53**(8):424-30

A treatment method is presented for eliminating perception of diplopia in patients with intractable diplopia and horror fusionis. Treatment emphasizes creating awareness of singleness in the periphery. Two cases are described.

Birnbaum MH
"Noncomitant strabismus: evaluation and management." *J Am Optom Assoc* 1984 Oct;**55**(10):758-64

A model is presented for the functional evaluation and management of noncomitant strabismus. The model considers the identification of noncomitancy and the differences in approach to evaluation and management depending upon whether the involvement is recent or longstanding.

Caloroso EE
"A sequential stategy for achieving functional binocularity in strabismus." *J Am Optom Assoc* 1988 May;**59**(5):378-87

The clinical approach to achieving functional binocularity for constant strabismus includes a series of sequential steps utilizing several therapy options. Passive therapy includes lenses, prisms, filters, occlusion, medications, and strabismus surgery. Active therapy adds visual exercises and/or self-monitoring systems such as biofeedback. Consideration of commonly used options and an overall sequential strategy is presented as a practical guide to the successful management of strabismic patients.

Campos EC Catellani T
"Further evidence for the fusional nature of the compensation (or 'eating up') of prisms in concomitant strabismus." *Int Ophthal* 1978 Sep;**1**(1):57-62

The fusional nature of the phenomenon of prism compensation in strabismus was studied. At first a general survey was performed on the characteristics of anomalous fusional movements (a.f.m.). The influence of different kinds of stimuli (foveal and peripheral fusionable targets, non-fusionable targets) on a.f.m. was considered, and finally the effect of a sensorial obstacle to fusion was investigated. It is concluded that 'eating up' the prisms is definitely a phenomenon of fusional nature, although it has special features which are interpreted as a consequence of the initial pathological condition. In this way the puzzling prism compensation also in subjects with normal retinal correspondence may be explained.

Condon PI
"The place of orthoptics in the provision of squint services in Ireland." *Ir Med J* 1980 Jan;**73**(1):2

Elmer J Fahmy YA Nyholm M et al.
"Extended wear soft contact lenses in the treatment of strabismic amblyopia." *Acta Ophthal* (Copenh) 1981 Aug;**59**(4):546-51

17 amblyopic children between 4 and 9 years were fitted with high power plus extended wear soft contact lenses (Scanlens 24 h, Duragel 75) for optical occlusion of strabismic amblyopia. Amblyopia and eccentric fixation responded quickly to treatment between 2 to 13 weeks. Only one patient failed to reach 6/9, and 11 patients achieved equal visual acuity. Out of

10 patients with eccentric fixation only two remained eccentric after treatment. The contact lenses were tolerated by the children. Among the problems, concerning the use of extended wear soft contact lenses, should be mentioned fitting problems, deposits, loss of lenses (1 child needed 4 lenses) and occurrence of conjunctivitis (5 eyes). No major infections were seen. A one year followup showed that almost all the children needed renewed occlusion treatment. It is therefore recommended to continue with contact lens occlusion for at total period of 3 months.

Eskridge JB Wick B Perrigin D
"The Hirschberg test: a double-masked clinical evaluation." *Am J Optom Physiol Opt* 1988 Sep;**65**(9):745-50

Though the Hirschberg test has been used for over a 100 years, several different formulas are still being recommended and used clinically to determine the amount of a given ocular deviation. The purpose of this study was to obtain a double-masked clinical evaluation of the Hirschberg test. Several strabismic patients were evaluated by one investigator using the alternate cover test and by another investigator using a photographic Hirschberg procedure in double-masked procedure. It was determined that the Hirschberg test can be used for strabismic patients of all ages and that the most appropriate formula to use is 1 mm = 22 delta.

Etting GL
"Strabismus therapy in private practice: Cure rates after three months of therapy." *J Am Optom Assoc* 1978 Dec;**49**(12):1367-73

Evens L
"History of strabismus treatment." *Bull Soc Belge Ophthal* 1981;**195**:19-52

Flax N
"Case presentation in strabismus." *J Am Optom Assoc* 1978 Nov;**49**(11):1283-5

Flax N Duckman RH
"Orthoptic treatment of strabismus." *J Am Optom Assoc* 1978 Dec;**49**(12):1353-61

Greenwald I
"Strabismus: Brock's influence on new therapies." Optometric Extension Program Mar 1982-Sep 1983;**54**(6)-55(12)

Hiles DA
"Results of strabismus therapy in cerebral palsied children." *Am Orthopt J* 1975;**25**:46-53

Hoffman L Cohen AH Feuer G et al.
"Effectiveness of optometric therapy for strabismus in a private practice." *Am J Optom Arch Am Acad Optom* 1970;**47**:990-5

This study is a compilation of analytical data on effective optometric treatment of strabismus patients. Available optometric knowledge and therapy can contribute to the successful handling of a great number of strabismic patients. More research in the psychophysiological aspects of strabismic behavior is needed, as is a resurgence of optometric practitioners specializing in the handling of strabismic patients.

Kertesz AE Kertesz J
"Wide-field fusional stimulation in strabismus." *Am J Optom Physiol Opt* 1986 Mar;**63**(3):217-22

The effectiveness of wide-field fusional stimulation was evaluated on 57 strabismics and 29 patients with convergence insufficiency. The strabismics had fusion, normal retinal correspondence (even if it coexisted with anomalous retinal correspondence), a deviation not exceeding 30 delta, and visual acuity of 6/7.5 or better. The strabismics included intermittent exotropes, surgically overcorrected intermittent exotropes, and accommodative esotropes. Of these strabismic patients, 42 responded to therapy in which tropias were converted to phorias or the frequency of the manifest deviation was significantly reduced, fusional amplitudes were significantly enlarged, and in many cases, stereoacuity improved as well. In 16 cases, surgery that was recommended before treatment is no longer being considered. Of the patients with convergence insufficiency, 23 responded to therapy which resulted in the enlargement of fusional amplitudes and the alleviation of symptoms. Followup visits (for up to 5 years) confirm that the improvement persists, which indicates the utility and effectiveness of this technique.

Ludlam WM Kleinman BI
"The long range results of orthoptic treatment of strabismus." *Am J Optom Arch Am Acad Optom* 1965 Nov;**42**(11):647-84

Paul HA Markow MJ
"Neurological organization exercises on retarded children with strabismus." *J Am Optom Assoc* 1969 Jul;**40**(7):706-9

Retkinski S
"Breaking down the adaptive state of an embedded alternator." Optometric Extension Program 1983 Oct;**55**(1):53

Scott WE Mash AJ Redmond MR
"Comparison of accommodative and non-accommodative targets for the assessment of ocular deviations." *Am Orthopt J* 1976;**26**:83-6

Soden R Cohen AH
"An optometric approach to the treatment of a non-comitant deviation." *J Am Optom Assoc* 1983 May;**54**(5):451-4

Weinstein E
"The effectiveness of strabismus training a year after dismissal." *Mo Optom* 1972;**52**(3)10-1

Wick B
"Prevention and care of strabismus in infants and pre-school children." *J Am Optom Assoc* 1979 Oct;**50**(10):1161-5

Care of children at risk of developing strabismus is discussed. Recommended care consists of parental counseling combined with early and periodic examinations. Examinations should begin by age 3 weeks and continue at 3-6 month intervals until the child reaches age 5. Treatment of strabismus or amblyopia should begin as soon as these conditions exist. Using recent electrophysiological research as a background, a model care for infants with congenital strabismus is presented. Care reports are presented describing results of orthoptic treatment of non-congenital strabismus.

Wick B London R
"The Hirschberg test: analysis from birth to age 5." *J Am Optom Assoc* 1980 Nov;51(11):1009-10

The theoretical conversion factor for the Hirschberg test was calculated from birth to age 5. This result, 1 mm = 19.5, delta remains essentially constant from birth.

Zaki HA
"Twenty years experience with squint patients." *Bull Ophthal Soc Egypt* 1971;**64**(68):221-6

Ziegler D Huff D Rouse MW
"Success in strabismus therapy: a literature review." *J Am Optom Assoc* 1982 Dec;**53**(12):979-83

The purpose of this study was to review the literature pertaining to non-surgical cure rates for strabismus published since 1958 and compare it to Flom's pronostic model. However, no studies were found that could be compared directly to Flom's model. One reason for this was due to the use of different definitions of a cure by different clinicians. Another reason was the failure to categorize the data according to the effect that retinal correspondence, frequency, and direction of the deviation had on the cure rates. From the studies which specified Flom's functional cure or its equivalent, it was determined that strabismic cure rates could be broken down as follows: Constant esotropia-29%; Intermittent esotropia-73%; Constant exotropia-53%; Intermittent exotropia-62%. Suggestions were made for the reporting of data to make future research more comparable and useful to the practitioner.

EXOTROPIA

Afanador AJ
"Auditory biofeedback and intermittent exotropia." *J Am Optom Assoc* 1982 Jun; **53**(6):481-3

Allen MJ
"How do you treat intermittent exotropia?" *Opt Wkly* 1968 August 29; **59**:17-8

Altizer LB
"The non-surgical treatment of exotropia." *Am Orthopt J* 1972;**22**:71-6

Birnbaum MH Klayman IM
"Optometric treatment of post-surgical constant exotropia." *Am J Optom Arch Am Acad Optom* 1972 Nov;**49**(11):951-3

> A post surgical constant exotrope was successfully treated, via optometric visual training, despite a prior history of five separate strabismus operations.

Burian HM
"Exodeviations: their classification, diagnosis and treatment." *Am J Ophthal* 1966 Dec;**62**(6):1161-6

Burian HM Franceschetti AT
"Evaluation of diagnostic methods for the classification of exodeviations." *Trans Am Ophthal Soc* 1970;**68**:56-71

Burian HM Smity DR
"Comparative measurement of exodeviations at twenty and one hundred feet." *Trans Am Ophthal Soc* 1971;**60**:188-99

Caltrider N Jampolsky A
"Overcorrecting minus lens therapy for treatment of intermittent exotropia." *Ophthal* 1983 Oct;**60**(8):678

> The purpose of this paper is to determine the value of overcorrecting minus lenses in treating children with intermittent exotropia. The aim with this therapy is to secure an increase in the quality of fusion and to induce a quantitative decrease in the angle of strabismus. Thirty-five children were treated with 2.00 to 4.00 diopters of over-correcting minus lenses for a median of 18 months duration. Of these, 46% had an improved quality of fusion during therapy; 26% had an improved quality of fusion and also had a quantitative decrease in their angle of deviation; and 28% had an inadequate improvement in their quality of fusion and decrease in the angle of their deviation with this therapy. Two children went from intermittent exotropia to esotropia while wearing their minus lenses--both had high accommodative-convergence/accommodation ratios (11.5 prism diopters/ 1 D and 10.7 prism diopters/1 D). Seventy percent of good responders who were followed for at least 1 year after discontinuing the therapy maintained a qualitative or quantitative improvement in their intermittent exotropia.

Chryssanthou G
"Orthoptic management of intermittent exotropia." *Am Orthopt J* 1974;**24**:69-72

Chutter CP
"Occlusion treatment of intermittent divergent strabismus." *Am Orthopt J* 1977;**27**:80-4

Duckman RH
"Management of binocular anomalies: efficacy of vision therapy, exotropia." *Am J Optom Physiol Opt* 1987 Jun;**64**(6):421-9

This paper presents a survey of the literature on management of the various forms of exotropia. Criteria for success of treatment are examined. A table summarizing the results of 11 studies is given.

Gallaway M Vaxmonsky T Scheiman M
"Management of intermittent exotropia using a combination of vision therapy and surgery." *J Am Optom Assoc* 1989 Jun;**60**(6):428-34

Vision therapy has been shown to provide higher success rate than surgery in the treatment of intermittent exotropia, but vision therapy is not successful in all cases. A case of intermittent exotropia is presented that illlustrates the use of vision therapy in combination with surgery. Issues that should be considered when selecting this treatment option are discussed.

Goldrich SG
"Oculomotor biofeedback therapy for exotropia." *Am J Optom Physiol Opt* 1982 Apr;**59**(4):306-17

Twelve exotropes of various types received oculomotor biofeedback therapy at State College of New York (SUNY) University Optometric Center. Feedback of a variable pitch tone which reflected changes in ocular vergence reinforced motor control of eye posture. Patients were trained to achieve and sustain alignment in a variety of viewing situations. The six intermittent exotropes in the study who did not have amblyopia or prior history of unsuccessful surgical or orthoptic therapy achieved the highest recovery rating after training. The amblyope and those who had orthoptic training learned to voluntarily correct their eye position, although they did not achieve as acute a sensitivity to loss of alignment as did the others. Therapy restored eye control at near in a young constant exotrope whose condition resulted from severe neurological dysfunction. A constant post-surgical exotrope who had no ability for sensory fusion made little progress. Advantages of oculomotor biofeedback therapy are shorter treatment time, elimination of lengthy home training exercises, and enhanced patient motivation.

Goldrich SG
"Optometric therapy of divergence excess strabismus." *Am J Optom Physiol Opt* 1980 Jan;**57**(1):7-14

A review and analysis of the vision training procedures were carried out over a period of 2 years at State University of New York (SUNY), University Optometric Center by 20 staff optometrists on 28 patients exhibiting divergence excess strabismus using models proposed by Flax and Greene. Training included motility, accommodative rock, fusion, antisuppression, and stereoscopic skills by a variety of techniques and devices. Patients who exhibited smaller pretraining angles of deviation, increased maturity, and greater motivation responded most successfully to treatment. The results achieved in this study compare favorably with those obtained by traditional orthoptic procedures.

Hoffman L Cohen AH
"Treatment of hyperopia associated with exotropia." *J Am Optom Assoc* 1975 Nov;**46**(11):1190-3

Letourneau JE Giroux R
"Using biofeedback in an exotropic aphake." *J Am Optom Assoc* 1984 Dec;**55**(12):909-10

Biofeedback has been used to achieve control over vergence, version, and torsion movements, nystagmus, amblyopia, strabismus, accommodation, and blepharospasm. This case report describes the use of auditory biofeedback and operant conditioning for cosmetic improvement in an aphakic patient.

Manny R Fannin T
"Treatment of intermittent exotropia at distance." *Opt Wkly* 1975 Jun;**66**:11-3.

A case report in which traditional use of base out training met with little success.

Niederecker O Scott W
"The value of diagnostic occlusion for intermittent exotropia." *Am. Orthopt. J.* 1975;**25**:88-91

It was found that the horizontal distance deviation in the primary position showed no significant difference between 24-hour and 45-minute occlusion. Sixty percent of patients with intermittent exotropia will have 2-10 degrees increase in distance deviation following 45-minute occlusion, there is a further increase of 5-7 degrees following five-day occlusion.

Rutstein RP Daum KM
"Exotropia associated with defective accommodation." *J Am Optom Assoc* 1987 Jul;**58**(7):548-54

Despite the close association of convergence and accommodation, accommodative dysfunction is not often associated etiologically with exotropia. We studied 13 adolescent and young adults having intermittent exotropia and severely reduced accommodative function. Most patients had a prolonged history of visual symptoms that had not responded to therapy in the past. Clinical testing indicated that the patients had severely reduced amplitudes of accommodation and difficulty sustaining accommodation. Exotropia was manifest when the accommodative response was inadequate; relative orthophoria existed when the accommodative response was adequate. Treatment of the accommodative defect as well as the strabismus was successful for some patients. We recommend careful evaluation of accommodation for adolescent and young adults with exotropia to rule out an accommodative defect as a contributing cause.

Rutstein RP Marsh-Tootle W London R
"Changes in refractive error for exotropes treated with overminus lenses." *Optom Vis Sci* 1989 Aug;**66**(8):487-91

The refractive changes of pediatric patients who were prescribed overminus lenses for exotropia were evaluated. Overminus lenses means additional minus power over the lenses required to correct the refractive error at distance. Forty exotropic patients, ages 1 to 15 years, were prescribed overminus lenses (-0.50 D to -3.75 D) for a period of 9 to 86 months. A small but significant correlation was found between the initial refractive error and the mean annual change toward myopia. Other factors such as age when treatment was given, duration of therapy, amount of overminus, and the amount of the exodeviation had little effect on the rate of myopic change. The mean annual changes in refractive error for hyperopes (-0.13 +/- 0.44 D, N = 15), emmetropes (-0.26 +/- 0.37 D, N = 17), and myopes (-0.75 +/- 0.77D, N = 18) were similar to values reported in the literature for nonexotropic children.

Sanfilippo S Clahane AC
"The effectiveness of orthoptics alone in selected cases of exodeviation: the immediate results and several years later." *Am Orthopt J* 1970;**20**:104-17

Selenow A Ciuffreda KJ
"Vision function recovery during orthoptic therapy in an exotropic amblyope with high unilateral myopia." *Am J Optom Physiol Opt* 1983 Aug;**60**(8):659-66

Orthoptic therapy was instituted in a 6 1/2-year-old patient having deep amblyopia, constant exotropia, and high unilateral myopia. The combination of these factors pointed toward a poor prognosis for attainment of normal monocular and binocular vision function. Rates of recovery of several vision functions were monitored during orthoptic therapy. Results showed marked improvement in most areas, thus providing evidence of neural plasticity at multiple sites in the visual pathways.

Shippman S Veronneau-Troutman S
"The effect of preoperative convergence exercises on the surgical outcome of primary exotropia." *Ophthalmology* 1979 Dec;**86**(12):2146-9

In a retrospective study of 89 patients with exotropia, the authors investigated the influence of active convergence exercises in the postoperative angle of deviation and found that convergence exercises do not increase the incidence or the size of the esodeviation postoperatively.

Tibbs A
"Orthoptic treatment of constant and intermittent exotropia." *Am Orthopt J* 1978;**28**:117-23

Tibbs A
"Pre- and post-operative treatment of constant and intermittent exotropia." *J Ped Ophthal* 1977 Sep-Oct;**14**(5):284-5

Intermittent exotropia is classified according to the AC/A ratio. Convergence amplitude measured on a light includes accommodative convergence. Amplitude measured while maintaining clear, single, binocular vision on 20/30 print utilizes only true fusional convergence.

Vishnoi SK Singh V Mehra MK
"Role of occlusion in treatment of intermittent exotropia." *Ind J Ophthal* 1987 Jul-Aug;**35**(4):207-10

Vodnoy BE
"Orthoptics of severe periodic exotropia." *Optom Wkly* 1975 Apr;**66**:292-295

A case study is described in which marked improvement was obtained in a patient with alternating, periodic exotropia at distance by training the positive fusional convergence, eliminating suppression, and performing jump ductions with polarized vectograms. Negative fusional reserves were trained following the enhancement of positive fusional ranges since an esophoria was found following extensive base out training.

Wick B
"'Forced elimination' of anomalous retinal correspondence in constant exotropia--a case report." *Am J Optom Physiol Opt* 1975 Jan;**52**(1):58-62

"Forced elimination" of anomalous correspondence in a patient with constant exotropia is discussed. Therapy was similar to classic visual therapy for esotropia: presenting targets at the angle of strabismus (Angle H) using a troposcope. Home therapy methods using anaglyphic techniques and afterimages are described.

ESOTROPIA

Bagolini B
"Postsurgical treatment of convergent strabismus, with a critical evaluation of various tests." *Int Ophthal Clin* 1966 Fall;**6**(3):633-67

Bixenman WW
"Management of nonrefractive accommodative esotropia." *Can J Ophthal* 1981 Jul;**16**(3):163-5

Bremner MH
"The use of spectacles in the treatment of congenital esotropia and amblyopia--a financial hazard." *Aust NZ J Ophthal* 1990 May;**18**(2):191-5

> Congenital esotropia and amblyopia are treated during the sensitive period of brain-eye development. Not all children require spectacles for treatment of these conditions but when refractive errors are present, correct and properly fitting spectacles play an important part. This prospective survey shows that one-third of the under three-year-old children wearing spectacles require surgery for esotropia, and that one-third of all children under eight years of age wearing spectacles need amblyopia treatment. It is uninterrupted treatment in these age groups that produce results. Approximately 50% of children wearing spectacles in the four-year-old and under group need a second or third pair of spectacles within a 12-month period. If these spectacles become unsuitable because of dense scratches, changed refraction or poor fit because of increasing PD, then the treatment is interrupted and the visual acuity is likely to regress. Many families cannot afford a second or third pair of spectacles within the 12-month period and hospital benefit funds often will not help. The treatment is interrupted. This financial hazard must be overcome.

Burian HM
"Accommodative esotropia. Classification and treatment." *Int Ophthal Clin* 1971 Winter;**11**(4):23-6

Christenson GN Rouse MW
"Management of a young esotrope using vision therapy and prismatic prescription." *J Am Optom Assoc* 1987 Jul;**58**(7):592-6

> This case report illustrates the important issues concerning optometric management of the pediatric patient presenting with esotropia. Appropriate treatment options and prognostic factors are covered. The case demonstrates the successful, sequential treatment of a young, early-onset, esotropic patient through vision therapy and prismatic lens prescription.

Christenson GN Rouse MW Adkins DA
"Management of infantile-onset esotropia." *J Am Optom Assoc* 1990 Jul;**61**(7):559-72

> Background information on the prevalence, clinical characteristics, and differential diagnosis of infantile-onset esotropia is presented. A brief overview of early development of binocularity is also presented to set the stage for management, as well as a sequential treatment plan for two age groups of infantile esotropes: 1) infants and toddlers, and 2) preschool and "older" patients. Flowcharts and case examples are included to highlight the management principles for attaining maximum binocular function.

Christian P
"The management of small-angle esotropia with abnormal retinal correspondence." *Am Orthopt J* 1971;**21**:92-5

Fletcher MC Silverman SJ Abbott W et al.
"Biostatistical studies. Results of biostatistical study of the management of alternating esotropia with and without orthoptics." *Am Orthopt J* 1969;**19**:31-9

Foster RS Paul TO Jampolsky A
"Management of infantile esotropia." *Am J Ophthal* 1976 Aug;**82**(2):291-9

Hiatt RL
"Miotics vs. glasses in esodeviation." *J Ped Ophthal* 1979;**16**:213-7

Both glasses and miotics were given to the same patients with esodeviations. The response to glasses was almost always better than the response to miotics. Miotics cannot be looked upon as a replacement to glasses in that they are not as equally effective. However, miotics may be an adjunct to other therapy in treatment of esodeviations.

Jacob JL Beaulieu Y Brunet E
"Progressive-addition lenses in the management of esotropia with a high accommodation/convergence ratio." *Can J Ophthal* 1980 Oct;**15**(4):166-9

In 25 children esotropia due to abnormal synkinesis between accommodation and accommodative convergence was corrected with progressive-addition lenses. Twelve of the children had been wearing conventional bifocals; the other 13 were given progressive lenses for the first time. The near esodeviation was satisfactorily neutralized in most cases, and nearly all the children had some stereopsis. All adapted well and without difficulty to the progressive lenses.

Kushner BJ Preslan MW Morton GV
"Treatment of partly accommodative esotropia with a high accommodative convergence-accommodation ratio." *Arch Ophthal* 1987 Jun;**105**(6):815-8

We conducted a prospective, randomized, masked comparison of two treatments for the nonaccommodative element in esotropic patients with a high accommodative convergence-accommodation ratio. One group received symmetric medial rectus recessions with posterior fixation sutures; the other received symmetric medial rectus recessions without posterior fixation sutures but augmented according to formula taking into account the near deviation. Previous experience had suggested that our surgical formula based solely on the distance deviation would lead to excessive undercorrections. A higher percentage of the augmented recession group achieved satisfactory alignment and were able to discontinue wearing bifocals postoperatively than the posterior fixation group. The data also showed a trend (though not statistically significant) suggesting that more members of the augmented recession group were able to discontinue wearing spectacles entirely. We concluded that the posterior fixation suture technique is not as effective as the augmented recession technique for the treatment of partly accommodative esotropia with a high accommodative convergence-accommodation ratio.

Ludwig IH Parks MM Getson PR
"Long-term results of bifocal therapy for accommodative esotropia." *J Ped Ophthal Strab* 1989 Nov-Dec;**26**(6):264-70

We studied the long-term course of 65 accommodative esotropes who required bifocals to maintain alignment at near. Average followup was 10.5 years. Forty patients (61.5%, group DC [bifocals discontinued]) were able to discontinue bifocal use after an average of 5.5 years wear. Twenty-five (38.5%) continued to wear bifocals (or a suitable alternative such as reading glasses), after an average 9.7 years of followup. Surgical correction of deteriorated accommodative esotropia was performed for 20 patients (50%) in group DC, and nine (36%) of those in group C [bifocals continued]. Surgery produced an average reduction in the accommodative con-

vergence relationship (near esodeviation in prism diopters [pd] minus corrected distance measurement, AC/A) of approximately 10 pd in both groups. Surgical patients unable to discontinue bifocal wear began with a clinically higher AC/A than those in group DC. Nonsurgical patients in group DC experienced spontaneous improvement of the AC/A over time (average, 6.2 pd). On average, this did not occur in those of group C. Average age of bifocal discontinuation was 9.7 years in surgical patients and 9.3 years in the non-surgical. Surgical patients had significantly lower hyperopia (+2.4 diopters [D]), than nonsurgical (+3.5 D), and an earlier age of onset of bifocal wear (3.29 versus 4.64 years). Although bifocals may be successfully discontinued in a majority of patients at an average age of 9.5 years, a significant percentage require long-term wear, some, despite surgery. The only factor that predicted long-term bifocal wear was a relatively high AC/A.

Moore S Cohen RL
"Orthoptic management of accommodative esotropia." *Am Orthopt J* 1977; **27**:119-23

Mortada A
"Treatment of 10 degree to 15 degree convergent residual angle left after surgery of partial accommodative esotropia in children." *Bull Ophthal Soc Egypt* 1968;**61**(65):205-10

Osias G Grisham JD
"Visual therapy for microtropia-esotropia." *Rev Opt* 1980 Jun;**117**(6):51-7.

Eso deviations are generally harder to treat successfully with orthoptics than exo deviations. This is very true if the eye turn is constant, or if it is associated with a microtropia (monofixation syndrome). This case of microtropia at distance and constant esotropia at near responded surprisingly well to a three-month visual therapy program consisting only of orthoptics and optical treatment.

Pratt-Johnson JA Tillson G
"The management of esotropia with high AC/A ratio (convergence excess)." *J Ped Ophthal Strab* 1985 Nov-Dec;**22**(6):238-42

This paper reviews the long-term followup of esotropia with a high AC/A ratio defined as an increase of 20 delta or more of the esotropia at near compared with distance with the full optical correction of any refractive error in place. Ninety-nine patients were studied for an average followup of eight years. Eighty-six achieved fusion but only five achieved central fusion. Forty-five were treated with bifocals. No significant difference in the sensory results were recorded in those patients wearing bifocals compared with those who did not wear bifocals. No patient had miotic therapy for more than a few months. The suppression characteristic of this condition is reviewed.

Pratt-Johnson JA Tillson G
"Sensory outcome with nonsurgical management of esotropia with convergence excess (a high accommodative convergence/accommodation ratio)." *Can J Ophthal* 1984 Aug;**19**(5):220-3

Twenty-seven patients with esotropia and convergence excess (a high accommodative convergence/accommodation [AC/A] ratio) managed nonsurgically underwent a final standardized evaluation of their sensory and motor status after a followup period of at least 8 years. All had a deviation with distance fixation of less than 10 prism dioptres (PD) of esotropia with full optical correction both initially and throughout the follow-up period. The average spherical-equivalent refractive error was +2.3 D. The AC/A ratio had tended to decrease with age, and most patients had fusion, although only a small proportion had central fusion and stereopsis. Approx-

imately half of the patients had been treated with bifocals, but their sensory outcome did not differ from that of the other patients. Miotics had not been used for more than a few months in any patient, as they were ineffective in reducing the deviation with near fixation to less than 10 PD of esotropia. A study, possibly a multicentre one, involving larger numbers of patients should be designed to find out whether bifocal therapy offers an advantage in the final sensory outcome of such patients.

Rutstein RP
"Therapy for early acquired noncomitant esotropia. A case report." *J Am Optom Assoc* 1983 Feb;**54**(2):161-3

A 7 year-old female demonstrated a noncomitant esotropia secondary to an early acquired lateral rectus paresis. Sensory fusion testing indicated that the patient was capable of maintaining single binocular vision only with a pronounced head turn. Prism and surgical therapy reduced the abnormal head posture and permitted fusion and stereopsis in the primary position.

Schnider CM Ciuffreda KJ Selenow A
"Orthoptic effects on accommodation and related visual functions in an adult alternating esotrope." *Ophthal Physiol Opt* 1985;**5**(4):425-33

Orthoptic therapy was instituted in an adult, alternating esotrope with asthenopia who exhibited inaccurate static accommodative responses with adequate, clinically determined, accommodative facility. During and following therapy the patient showed considerable improvement in accommodative accuracy and related visual functions, such as contrast sensitivity, in the absence of any change in strabismic deviation. This case provides the first laboratory documentation of orthoptic effects on accommodation in an adult strabismic.

Selenow A Ciuffreda KJ
"Vision function recovery during orthoptic therapy in an adult esotropic amblyope." *J Am Optom Assoc* 1986 Feb;**57**(2):132-40

Orthoptic therapy was instituted in a 29-year-old patient having moderate amblyopia, constant small-angle esotropia, and large and steady eccentric fixation. This combination of factors, especially the age, pointed toward a poor prognosis for attainment of markedly improved vision function. Rate of recovery of several monocular vision functions was monitored during one year of orthoptic therapy. Results showed substantial improvement in most areas, thus providing evidence of neural plasticity at multiple sites in the visual pathways in this adult amblyope.

Simonsz HJ
"Treatment of partly accommodative esotropia with a high accommodative convergence-accommodation ratio" [letter] *Arch Ophthal* 1988 Apr;**106**(4):447-8

Singha JN
"Penalisation therapy in a residual concomitant convergent squint--a case report." *Ind J Ophthal* 1981 Dec;**29**(4):425-6

Sleight JL Mashikian M
"Haidinger brush diagnosis and treatment of binocular suppression scotoma in intermittent, accommodative and postoperative esotropia." *Am Orthopt J* 1971;**21**:96-100

Smith JB
"Progressive-addition lenses in the treatment of accommodative esotropia." *Am J Ophthal* 1985 Jan;**99**(1):56-62

Thirty-two children ranging in age from 18 months to 16 years were treated for accommodative esotropia with variable-focus lenses instead of executive bifocals. The major advantages were the improved appearance of the glasses and the more natural progression of accommodative treatment from distance to near which provided more relaxation of convergence in the intermediate zone. The chief disadvantage was the difficulty fitting small children with lenses that were originally designed for the use of presbyopic adults. The maximum power for the effective control of the deviation for reading is at the bottom of the lens. Keeping this portion of the lens high enough proved to be difficult in small children. None of the patients were willing to return to executive bifocals after having worn progressive-addition lenses.

Smith JB
"Treatment of esotropia with progressive-addition lenses." *Am Orthopt J* 1986;**36**:127-130

For the past three years, progressive-addition lenses have been successfully prescribed as a substitute for executive bifocals and cholinesterase inhibitors in the treatment of accommodative esotropia. The use of these "invisible bifocals" was originally designed to improve the appearance of the glasses, but the lenses have also provided more secure control of the deviation in the intermediate distance. In addition, maximum accommodative treatment can be given a patient without fusion to obtain a cosmetically acceptable angle of deviation distance and near without the stigma of bifocals.

"Treating infant esotropia: a case report." *Am J Optom Physiol Opt* 1978 Jul;**55**(7):463-5

A case study is presented of a child who had a constant left esotropia since birth. The patient was first seen at age 8 mo, after an ophthalmolgical opinion had suggested immediate surgery. The therapy and its success are discussed.

von Noorden GK
"Tests of binocular function after surgery for infantile esotropia." [letter] *Can J Ophthal* 1983 Jun;**18**(4):205-6

von Noorden GK Morris J Edelman P
"Efficacy of bifocals in the treatment of accommodative esotropia." *Am J Ophthal* 1978 Jun;**85**(6):830-4

We treated 84 patients with a partially refractive accommodative esotropia with bifocals. Twelve patients were able to fuse without bifocals at the end of therapy; in 19, the bifocal power could be reduced and further improvement can be expected in the future. Thirty-nine remained dependent on bifocals; and in 14, fusion had deteriorated in spite of therapy. Patients with a high AC/A ratio and those receiving supportive orthoptic treatment seemed to fare best with bifocals. In those with a low AC/A ratio, fusion tended to deteriorate because of a slowly increasing esodeviation at near fixation.

Wick B
"Accommodative esotropia: efficacy of therapy." *J Am Optom Assoc* 1987 Jul;**58**(7):562-6

Retrospective examination was performed on the records of 54 patients who had undergone treatment of accommodative esotropia. The patients were classified based on the Duane classification as having either convergence excess (n = 11) or equal esodeviations (n = 43). Over 90% of the patients achieved total restoration of normal binocular function with treatment. The results and implications of this study are discussed.

Wick B
"Home visual therapy for constant esotropia with anomalous correspondence." *Am J Optom Physiol Opt* 1978 Dec;**55**(12):836-9

A home therapy method for eliminating anomalous correspondence is described. This method is applicable to patients over 12-yr old with esotropia greater than 15-20 delta. A case report included.

Wick B
"Visual therapy for small angle esotropia." *Am J Optom Physiol Opt* 1974 Jul;**51**(7):490-6

Wilcox LM Jr Sokol S
"Changes in the binocular fixation patterns and the visually evoked potential in the treatment of esotropia with amblyopia." *Ophthalmology* 1980 Dec;**87**(12):1273-81

Using the binocular fixation pattern (BFP) and the visually evoked potential (VEP), thirteen amblyopic patients with comitant, non-accommodative esotropia with an angle range up to 30 delta were studied before and during occlusion therapy. A graded BFP with a stronger preferred fixation could be used to diagnose amblyopia. The BFP, however, showed no significant change with therapy despite improvement in acuity. In contrast, the VEP amplitudes, initially reduced in amblyopia, increased significantly as the vision responded to patching. The VEP was useful in diagnosing strabismic amblyopia and giving a predictive range of acuities.

ANOMALOUS RETINAL CORRESPONDENCE

Cibis L
"Penalization, treatment of ARC and amblyopia." *Am Orthopt J* 1975; **25**:79-84

Christian P
"The management of small-angle esotropia with abnormal retinal correspondence." *Am Orthopt J* 1971;**21**:92-5

Cook DL
"Considering the ocular motor system in the treatment of anomalous retinal correspondence." *J Am Optom Assoc* 1984 Feb;**55**(2):109-17

For over fifty years optometrists have treated anomalous retinal correspondence with techniques which may owe much of their success to an effect on the motor system. This paper will review a sample of these techniques and speculate on how considering the motor system may enhance strabismus therapy.

Davis MR Hoffman LG
"A three step method of the determination of fixation status and retinal correspondence." *J Am Optom Assoc* 1983 Sep;**54**(9):807-9

In examination and treatment of patients with strabismus one often encounters abnormal sensory adaptations such as eccentric fixation and anomalous retinal correspondence. Prognosis and treatment of strabismus are dependent on the presence or absence of these conditions. When eccentric fixation is present it becomes difficult to interpret the results of many tests used to determine retinal correspondence. This determination is further complicated when the patient is unable to give accurate responses. A technique utilizing visuoscopy and an afterimage has been performed on somewhat less cooperative patients. The results compare favorably to amblyoscopic measurements of the angle of anomaly.

Flom MC Kerr KE
"Determination of retinal correspondence. Multiple-testing results and the depth of anomaly concept." *Arch Ophthal* 1967 Feb;**77**(2):200-13

Fors LA Marshall NF
"Bagolini lenses vs. PFL filters in the diagnosis of correspondence." *J Am Optom Assoc* 1989 Feb;**60**(2):132-5

This study introduces a new product, the PFL 7501 filter (prism linear filter), as a test for correspondence. Thirty consecutive strabismic subjects were asked to verbally describe, then draw, the images seen from a small light source through the Bagolini #4 striated lenses and the PFL 7501 filters. A 97% concordance was found between the two materials. The bright, multicolored streaks seen through the PFL filters were easier for all subjects to see and describe than the images seen through the Bagolini striated lenses.

Griffin JR
"Comments on a novel method of detection of anomalous retinal correspondence." *Opt Mthy* 1980 Jun:45-7.

Porter's retinoscopic technique was tested and is compared with the Hering-Bielschowsky afterimage test for detecton of anomalous correspondence.

Rouse M Calorosa E
"A new method of concomitancy testing." *Am J Optom Physiol Opt* Jan 1980; **57**(1):56-63

Concomitancy is one of several factors to measure when performing a complete diagnostic evaluation of heterotropias and heterophorias. When the fusion-free position of the eyes varies significantly in magnitude or direction in different fields of gaze, nonconcomitancy exists. Frequently the testing of concomitancy is overlooked or performed with little precision. Yet, concomitancy testing is important because the existence and amount of nonconcomitancy may influence the prognosis, therapeutic approach, and success in treatment, and may indicate some life-threatening systemic problem which requires referral. A specially designed light-emitting diode target screen was combined with the projection system of the B & L Autoplot. This system allows the Hess-Lancaster test to be performed quickly and accurately with automatic recording of the patient's responses.

Soden R Cohen AH
"An optometric approach to the treatment of a non-comitant deviation." *J Am Optom Assoc* 1983 May;**54**(5):451-4

Veronneau-Troutman S
"The role of orthoptics in amblyopia and abnormal retinal correspondence." *Int Ophthal Clin* 1971 Winter;**11**(4):300-5

Wick B
"Anomalous after-image transfer--an analysis and suggested method of elimination." *Am J Optom Physiol Opt* 1974 Nov;**51**(11):862-71

Wick B
"'Forced elimination' of anomalous retinal correspondence in constant exotropia--a case report." *Am J Optom Physiol Opt* 1975 Jan;**52**(1):58-62

"Forced elimination" of anomalous correspondence in a patient with constant exotropia is discussed. Therapy was similar to classic visual therapy for esotropia: presenting targets at the angle of strabismus (Angle H) using a troposcope. Home therapy methods using anaglyphic techniques and afterimages are described.

Wick B
"Home visual therapy for constant esotropia with anomalous correspondence." *Am J Optom Physiol Opt* 1978 Dec;**55**(12):836-9

A home therapy method for eliminating anomalous correspondence is described. This method is applicable to patients over 12-yr old with esotropia greater than 15-20 delta. A case report included.

Wick B Cook D
"Management of anomalous correspondence: efficacy of therapy." *Am J Optom Physiol Opt* 1987 Jun;**64**(6):405-10

The last paper to review thoroughly the success of treatment for esotropia with anomalous correspondence was published by Flom in 1963. In reviewing the literature of that era, which included surgical intervention, Flom found documented cures in only 11 of 262 esotropic patients with anomalous correspondence--a cure rate of less than 5%. We evaluated recent reported success rates for treatment and present an estimate of the prognosis for successful binocular reeducation of patients with esotropia and anomalous correspondence. Based on current therapy techniques reported in the literature, with careful aggressive therapy, 50% of esotropic patients with anomalous correspondence should be expected to achieve binocular vision provided sufficient time (up to 12 months) can be devoted to binocular reeducation.

MICROTROPIA

London R Wick B
"Relationship between fixation disparity curves and symptoms in monofixators." *J Am Optom Assoc* 1982 Nov;**53**(11):881-4

Patients with small angle strabismus usually are asymptomatic. Occasionally, however, binocular asthenopic symptoms are reported. Two monofixators, one symptomatic and the other asymptomatic, with similar profiles on strabismic evaluation had forced vergence Fixation Disparity Curves (FDC) measured. Slope of the FDC may help to discriminate between the symptomatic and asymptomatic patient.

Osias G Grisham JD
"Visual therapy for microtropia-esotropia." *Rev Opt* 1980 Jun;**117**(6):51-7.

Eso deviations are generally harder to treat successfully with orthoptics than exo deviations. This is very true if the eye turn is constant, or if it is associated with a microtropia (monofixation syndrome). This case of microtropia at distance and constant esotropia at near responded surprisingly well to a three-month visual therapy program consisting only of orthoptics and optical treatment.

VERTICAL DEVIATIONS

Cooper J
"Orthoptic treatment of vertical deviations." *J Am Optom Assoc* 1988 Jun;**59**(6):463-8

Four patients with large vertical deviations were treated with a combination of prismatic glasses and orthoptics. The least amount of prism which eliminated diplopia, followed by horizontal fusional range extension, was prescribed. After vergences were normalized the prism was further reduced by two prism diopters and horizontal fusional range extension was repeated. This process was repeated until either a plateau was achieved or the prism was eliminated. All four patients completed therapy with almost total alleviation of symptoms and elimination of fulltime prismatic correction.

Eskridge JB Rutstein RP
"Clinical evaluation of vertical fixation disparity. Part IV. Slope and adaptation to vertical prism of vertical heterophoria patients." *Am J Optom Physiol Opt* 1986 Aug;**63**(8):662-7

The purpose of this study was to determine the characteristics of the clini-cally measured vertical fixation disparity (VFD) curve and the ability to adapt to vertical prism for patients who have a vertical heterophoria and are comfortably wearing vertical prism, and to relate these data to similar findings for nonvertical heterophoria patients. The correlation between the amount of vertical prism that was being worn comfortably and the amount of vertical prism that reduced the VFD to zero was also evaluated. The results indicate that patients with vertical heterophoria who are wearing vertical prismatic corrections comfortably have VFD curves with shapes and slopes similar to nonvertical heterophoria patients; have lower coefficients of adaptability to vertical prism than nonvertical heterophoria patients; and the amount of the vertical prismatic correction to produce visual comfort can be determined by the vertical prism that reduces the VFD to zero.

Moore S Stockbridge L
"Fresnel prisms in the management of combined horizontal and vertical strabismus." 1972;**22**:14-21

Fresnel prisms were prescribed first for only the horizontal component of patients with combined vertical and horizontal strabismus. If the vertical deviation is not eliminated and bifoveal fixation is not present, the prisms are reapplied in an oblique manner so that both the horizontal and vertical components of the strabismus are compensated. The Fresnel prisms were found to be helpful in eliminating diplopia in the visually mature patient and as a temporary measure for certain patients requiring surgery.

Padula WV
"The reduction of vertical phorias through kinesthetic reinforcement." *J Opt Vision Dev* 1979;**10**(3):3-9

Vertical deviations have been related to many symptoms varying in severity; optometric treatment has shown limited successes using traditional approaches of prisms and lenses. This paper discloses therapy techniques utilizing kinesthetic reinforcement that have shown to be effective in reducing vertical deviations and associated symptoms.

Reinecke RD Simons K Moss A et al.
"An improved method of fitting resultant prism in treatment of two-axis strabismus." *Arch Ophthal* 1977 Jul;**95**(7):1255-7

A new chart determines resultant prism power and angle when correction of combined horizontal and vertical deviation with a single prism, set at an angle intermediate between horizontal and vertical, is desired. The chart is based on a derivation so weighted as never to permit a vertical error greater than one tenth as large as the associated horizontal error, with use of commercially available sizes of plastic Fresnel-type prisms. This weighting takes into account differences in horizontal and vertical fusional reserves. A compass rose facilitates proper alignment of the prisms.

Robertson KM Kuhn L
"Case report: Successful vision training for alternating sursumduction." *J Am Optom Assoc* 1984 Dec;**55**(12):911-4

Veronneau-Troutman S
"A new optical modality to overcome diplopia." *Trans Am Ophthal Soc* 1979;**77**:181-90

The author has presented a new method to correct vertical diplopia using a prism contact lens. To the present time, its application has been limited to contact lenses correcting refractive errors of less than 3D and to ground-in prisms of not more than 6 delta. The field is new. Technical, mathematical, and clinical advances should eventually allow the use of stronger prisms over a wider range of refractive corrections.

BIOFEEDBACK IN STRABISMUS THERAPY

Afanador AJ
"Auditory biofeedback and intermittent exotropia." *J Am Optom Assoc* 1982 Jun;**53**(6):481-3

Goldrich SG
"Oculomotor biofeedback therapy for exotropia." *Am J Optom Physiol Opt* 1982 Apr;**59**(4):306-17

Twelve exotropes of various types received oculomotor biofeedback therapy at State College of New York (SUNY) University Optometric Center. Feedback of a variable pitch tone which reflected changes in ocular vergence reinforced motor control of eye posture. Patients were trained to achieve and sustain alignment in a variety of viewing situations. The six intermittent exotropes in the study who did not have amblyopia or prior history of unsuccessful surgical or orthoptic therapy achieved the highest recovery rating after training. The amblyope and those who had orthoptic training learned to voluntarily correct their eye position, although they did not achieve as acute a sensitivity to loss of alignment as did the others. Therapy restored eye control at near in a young constant exotrope whose condition resulted from severe neurological dysfunction. A constant postsurgical exotrope who had no ability for sensory fusion made little progress. Advantages of oculomotor biofeedback therapy are shorter treatment time, elimination of lengthy home training exercises, and enhanced patient motivation.

Hirons R Yolton RL
"Biofeedback treatment of strabismus: case studies." *J Am Optom Assoc* 1978 Aug;**49**(8):875-82

This project demonstrates the use of neuromuscular reeducation biofeedback as a treatment for strabismus. Of the three subjects treated, an exotrope and an esotrope were cured according to predefined criteria and an exotrope with a dense monocular cataract was improved. Treatment consisted of monitoring eye positions using infrared sensors and feeding back information on relative ocular deviations coded in the form of a tone.

Letourneau JE Giroux R
"Using biofeedback in an exotropic aphake." *J Am Optom Assoc* 1984 Dec;**55**(12):909-10

Biofeedback has been used to achieve control over vergence, version, and torsion movements, nystagmus, amblyopia, strabismus, accommodation, and blepharospasm. This case report describes the use of auditory biofeedback and operant conditioning for cosmetic improvement in an aphakic patient.

Palmer RD Siegel M
"Electromyographic feedback in strabismus." *Biofeedback Self-Reg* 1977;**2**(3):316

van Brocklin MD Vasche TR Hirons RR Yolton RL
"Biofeedback enhanced strabismus therapy." *J Am Optom Assoc* 1981 Sep;**52**(9):731-6

Previous work, conducted under laboratory conditions, has shown that biofeedback using infrared eye position monitoring can be used to successfully treat strabismus. For the present study, seven matched pairs of strabismic patients were selected. One member of each pair received biofeedback enhanced vision therapy while the other member received traditional vision therapy. Cover test data obtained during each training session showed an

advantage in using biofeedback enhanced training in several but not all cases. It is suggested that the optimum use of biofeedback may be prior to traditional training rather than integrated with it.

AMBLYOPIA-GENERAL

Alexander KR Berman MS
"The effect of light flashing at 9 Hertz on rivalry suppression." *Am J Optom Physiol Opt* 1978 Jun;**55**(6):390-3

The translid binocular interactor (TBI), which presents binocularly out-of-phase lights flashing at 9 Hz, was designed to reduce suppression of amblyopes. To determine the effect of such flashing lights on rivalry suppression, subjects who showed strong suppression during binocular rivalry were exposed to a modified form of the TBI for a total of 2 2/3 hr over 4 days. A similar group of subjects was exposed to steady binocular light. The modified TBI had no effect on rivalry suppression; the changes in suppression that did occur were equivalent in the two groups.

Banks RV Campbell FW Hess R et al.
"A new treatment for amblyopia." *Br Orthopt J* 1978:**35**(1):1-12

Good results have been obtained in the treatment of amblyopia by rotating high contrast square-wave grating discs. Each treatment session lasts for 7 minutes and the average number of treatment sessions required to acheive the maximum visual acuity in the first group of 40 patients is 4.

Barbeito R Bedell HE Flom MC et al
"Effects of luminance on the visual acuity of strabismic and anisometropic amblyopes and optically blurred normals." *Vision Res* 1987; **27**(9):1543-9

Evidence is accumulating to suggest fundamental differences between strabismic and anisometropic amblyopia. We explored differences in these amblyopes by assessing the effects of luminance on optotype acuity, using targets that ranged from photopic to low mesopic levels. Our results show that reducing luminance has less of a detrimental effect on the acuity of strabismic than anisometropic amblyopic eyes. Furthermore, the effect of decreasing luminance on the acuity of optically blurred normal eyes mimicked the effect we found for anisometropic amblyopic eyes. These results are consistent with the hypothesis that the fundamental deficit in anisometropic amblyopia is impaired resolution while in strabismic amblyopia the fundamental deficit is impaired spatial directionalization.

Birnbaum MH Koslowe K Sanet R
"Success in ambylopia therapy as a function of age: a literature survey." *Am J Optom Physiol Opt* 1977 May;**54**(5):269-75

It is frequently stated that amblyopia is not correctable after the age of 6 years. Many practitioners report marked success for older patients. To evaluate these conflicting reports, we analyzed the results from 23 published amblyopia studies. Our analysis indicates that substantial numbers of patients over age 6 were successfully treated. Success rates under age 6 were not significantly better than those in older patients when the criterion for success was achievement of 20/30 acuity or better. When a criterion of 4 lines improvement was used, success rates at all ages under 16 were quite similar; in patients 16 and over, success by this criterion was significantly less frequent, but even in this group success was achieved by 42% of the patients.

Bremner MH
"The use of spectacles in the treatment of congenital esotropia and amblyopia--a financial hazard." *Aust NZ J Ophthal* 1990 May;**18**(2):191-5

Congenital esotropia and amblyopia are treated during the sensitive period of brain-eye development. Not all children require spectacles for treatment

of these conditions but when refractive errors are present, correct and properly fitting spectacles play an important part. This prospective survey shows that one-third of the under three-year-old children wearing spectacles require surgery for esotropia, and that one-third of all children under eight years of age wearing spectacles need amblyopia treatment. It is uninterrupted treatment in these age groups that produce results. Approximately 50% of children wearing spectacles in the four-year-old and under group need a second or third pair of spectacles within a 12-month period. If these spectacles become unsuitable because of dense scratches, changed refraction or poor fit because of increasing PD, then the treatment is interrupted and the visual acuity is likely to regress. Many families cannot afford a second or third pair of spectacles within the 12-month period and hospital benefit funds often will not help. The treatment is interrupted. This financial hazard must be overcome.

Burian HM
"The behavior of the amblyopic eye under reduced illumination and the theory of functional amblyopia." *Doc Ophthal* 1967;**23**:189-202

Burian HM
"Pathophysiologic basis of amblyopia and of its treatment." *Am J Ophthal* 1969 Jan;**67**(1):1-12

Burian HM
"Treatment of functional amblyopia." *Sight Sav Rev* 1971;**41**(2):69-81

Cibis L Windsor C
"Clinical results with passive amblyopia treatment." *Am Orthopt J* 1967; **17**:56-61

Ciuffreda KJ Kenyon RV Stark L
"Different rates of functional recovery of eye movements during orthoptics treatment in an adult amblyope." *Inv Ophthal Vis Sci* 1979 Feb; **18**(2):213-9

Although it is common clinical knowledge that oculomotor control appears to normalize during the course of successful orthoptics therapy for amblyopia, reports providing a quantitative analysis of eye movements during extended periods of treatment are lacking. We provide for the first time such a report in an adult amblyope. Aspects of eye movement control that tended to normalize with therapy include drift amplitude and velocity, duration and frequency of steady fixation, and pursuit gain. These results suggest that smooth pursuit control can be modified, even in an adult amblyope. Aspects of eye movement control that remained abnormal throughout therapy, in spite of normalization of visual acuity and centralization of fixation, include increased saccadic latencies, use of large saccades during small-amplitude pursuit tracking, and static overshooting. These results suggest that certain aspects of saccadic and pursuit control could either no longer be modified or would require longer periods for this to occur.

Cohen AH
"Monocular fixation in a binocular field." *J Am Opt Assoc* 1981 Oct; **52**(10): 801-6

A model is presented which incorporates a behavioral aspect to amblyopia as well as a new approach to the treatment of amblyopia. The thrust is a dynamic sequence geared to the development of improving performance of the amblyopic eye under binocular conditions.

Eibschitz N Friedman Z Neuman E
"Comparative results of amblyopia treatment." *Metab Ophthal* 1978;**2**: 111-2

Eiden SB
"Vision therapy helps adult amblyope." *Rev Optom* 1982 Sep;**119**(9):62

Vision training improved binocularity and working comfort in an amblyope whose trouble with near work almost made him give up dental practice.

el-Defrawi H
"Clinical results with amblyopia treatment in children above five years old." *Bull Ophthal Soc Egypt* 1970;**63**(67):433-50

Elmer J Fahmy YA Nyholm M et al.
"Extended wear soft contact lenses in the treatment of strabismic amblyopia." *Acta Ophthal* (Copenh) 1981 Aug;**59**(4):546-51

17 amblyopic children between 4 and 9 years were fitted with high power plus extended wear soft contact lenses (Scanlens 24 h, Duragel 75) for optical occlusion of strabismic amblyopia. Amblyopia and eccentric fixation responded quickly to treatment between 2 to 13 weeks. Only one patient failed to reach 6/9, and 11 patients achieved equal visual acuity. Out of 10 patients with eccentric fixation only two remained eccentric after treatment. The contact lenses were tolerated by the children. Among the problems, concerning the use of extended wear soft contact lenses, should be mentioned fitting problems, deposits, loss of lenses (1 child needed 4 lenses) and occurrence of conjunctivitis (5 eyes). No major infections were seen. A one year followup showed that almost all the children needed renewed occlusion treatment. It is therefore recommended to continue with contact lens occlusion for at total period of 3 months.

Flax N
"Some thoughts on the clinical management of amblyopia." *Am J Optom Physiol Opt* 1983 Jun;**60**(6):450-3

Brief periods of ocular occlusion, coupled with careful reinforcement of the desired behavior, are frequently more effective than prolonged direct occlusion in the treatment of amblyopia.

Flom MC Kirschen DG Bedell HE
"Control of unsteady, eccentric fixation in amblyopic eyes by auditory feedback of eye position." *Inv Ophthal Vis Sci* 1980 Nov;**19**(11):1371-81

A technique for providing amblyopes with auditory feedback signals of eye position errors is described. With auditory cues, 12 adult eccentrically fixing amblyopes with strabismus and/or anisometropia have been able to maintain steady and foveal fixation with the amblyopic eye. The changes observed in fixation patterns with auditory feedback were both quantitative and qualitative; with such feedback, amblyopes often exhibited sequences of normal-appearing fixation. Some of our sujects have been successful in maintaining steady foveal fixation for short periods of time after feedback is turned off, apparently using visual error signals. For two subjects, feedback also promoted major improvements in smooth tracking performance. We conclude that the use of auditory feedback of eye position has significant value for basic studies of the mechanisms underlying amblyopia and potentially for the clinical treatment of this condition.

Garzia RP
"Efficacy of vision therapy in amblyopia: a literature review." *Am J Optom Physiol Opt* 1987 Jun;**64**(6):393-404

In this paper the major optometric, ophthalmologic, and orthoptic literature on the efficacy of vision therapy for amblyopia has been surveyed. Over the past four decades there are many examples of the successful treatment of amblyopia in the form of well documented individual case reports or large sample studies. Although occlusion of the dominant eye has been applied universally, there are some instances of the successful use of

minimal occlusion combined with extensive visual-motor therapy. Overall, the results of the literature review strongly support the use of active vision therapy as an integral part of the clinical treatment of amblyopia.

Gould A Fishkoff D Galin MA
"Active visual stimulation: a method of treatment of amblyopia in the older patient." *Am Orthopt J* 1970;**20**:39-45

Gregersen E
"Occlusion treatment of squint amblyopia in young adults." *Acta Ophthal* 1966;**44**:166-8

Gregersen E Rindziunski E
"Conventional occlusion in the treatment of squint amblyopia." *Acta Ophthal* 1965;**43**:462-74

Hittner HM Chokshi DB
"Results of treatment in unilateral high myopia with amblyopia." *Am Orthopt J* 1978;**28**:74-7

Hokoda SC Ciuffreda KJ
"Different rates and amounts of vision function recovery during orthoptic therapy in an older strabismic amblyope." *Ophthal Physiol Opt* 1986; **6**(2):213-20

Orthoptic therapy was instituted in an 11-year-old patient having deep amblyopia, constant small-angle esotropia with anomalous retinal correspondence, and a past history of minimal success with such therapy. This combination of factors pointed toward a poor prognosis for substantial recovery of vision function. Rate of recovery of several monocular and binocular vision functions was monitored during the course of 18 months of intensive orthoptic therapy. Results showed marked improvement in several monocular vision functions, suggesting presence of considerable residual neural plasticity of multiple sites in the visual pathways of this older amblyope.

Ingram RM Walker C Wilson JM et al.
"A first attempt to prevent amblyopia and squint by spectacle correction of abnormal refractions from age 1 year." *Br J Ophthal* 1985 Nov;**69** (11):851-3

Spectacle correction of unusually hypermetropic refractions from age 1 year did not reduce the incidence of squint or amblyopia, nor did it lead to a reduction in the severity of residual amblyopia after subsequent occlusion.

Lawmill T Burian HM
"Luminance, contrast function and visual acuity in functional amblyopia." *Am J Ophthal* 1966 Sep;**62**(3):511-20

Leyman IA
"A comparative study in the treatment of amblyopia." *Am Orthopt J* 1978; **28**:95-8

Limpaecher E
"Amblyopia therapy: methods and results." *Am Orthopt J* 1969; **19**:97-103

Lizotte EH Jr
"An outline for amblyopia testing and reduction." *J Am Optom Assoc* 1969 May;**40**(5):531-2

Lyle TK
"A study of the long-term results of the treatment of amblyopia in cases of squint in which fixation was not eccentric." *Doc Ophthal* 1967; **23**:511-21

Mohindra I
"Early treatment of anisometropic astigmatism and strabismus." *Am J Optom Physiol Opt* 1977 Jul;**54**(7):479-84

A 4-year-old boy with uncorrected anisometropic indirect astigmatism showed amblyopia and strabismus. Over a period of approximately 3 yr, neutralization of the refractive error and treatment of the amblyopia and strabismus resulted in single binocular vision with good stereopsis. The results suggest that at least up to age 7 the visual system is sufficiently plastic to be modified by treatment.

Morton RE
"The treatment of amblyopia." *Ophthalmic Physiol Opt* 1982;**2**(3):235-8

Nawratzki I
"Treatment of amblyopia." *Ir J Med Sci* 1972;**8**:1475-9

Pickwell LD Jenkins TCA
"Response to amblyopia treatment." *Aust J Opt* 1983 Jan;**66**(1):29-33

The response of patients to treatment for amblyopia is considered in two age groups, 5-9 and 11-19 years. The percentage of patients who improved by two Snellen lines and the degree of improvement was better for the lower age range, but a significant number of the teenage patients improved. No greater success for anisometropic amblyopia was found compared to strabismic amblyopia, but the methods found to be effective differed between the types of amblyopia and the two age groups.

Rosenthal AR Von Noorden GK
"Clinical findings and therapy in unilateral high myopia associated with amblyopia." *Am J Ophthal* 1971 Apr;**71**(4):873-9

Saladin JJ Bohman CE
"Anaglyphic T.V. ping pong antisuppression trainer." *J Am Optom Assoc* 1977 Jul;**48**(7):929-32

Orthoptic therapy often entails the repetitive usage of detailed and complicated training procedures. Amblyopia and antisuppression therapy in particular may require weeks or months of training. A multipurpose training device has been constructed from commercially available components and promises to maintain a high level of patient interest and cooperation throughout the training procedure.

Saulles H
"Treatment of refractive amblyopia in adults." *J Am Optom Assoc* 1987 Dec;**58**(12):959-60

Treatment of amblyopia has been relatively ignored in the adult population. In a retrospective study at the University of Michigan Health Service, 10 patients with refractive amblyopia showed visual acuity improvement in their amblyopic eye after completing simple vision therapies.

Selenow A Ciuffreda KJ
"Vision function recovery during orthoptic therapy in an adult esotropic amblyope." *J Am Optom Assoc* 1986 Feb;**57**(2):132-40

Orthoptic therapy was instituted in a 29-year-old patient having moderate amblyopia, constant small-angle esotropia, and large and steady eccentric fixation. This combination of factors, especially the age, pointed toward a poor prognosis for attainment of markedly improved vision function. Rate of recovery of several monocular vision functions was monitored during one year of orthoptic therapy. Results showed substantial improvement in most areas, thus providing evidence of neural plasticity at multiple sites in the visual pathways in this adult amblyope.

Selenow A Ciuffreda KJ
"Vision function recovery during orthoptic therapy in an exotropic amblyope with high unilateral myopia." *Am J Optom Physiol Opt* 1983 Aug;**60**(8):659-66

Orthoptic therapy was instituted in a 6 1/2-year-old patient having deep amblyopia, constant exotropia, and high unilateral myopia. The combination of these factors pointed toward a poor prognosis for attainment of normal monocular and binocular vision function. Rates of recovery of several vision functions were monitored during orthoptic therapy. Results showed marked improvement in most areas, thus providing evidence of neural plasticity at multiple sites in the visual pathways.

Selenow A Ciuffreda KJ Mozlin R et al.
"Prognostic value of laser interferometric visual acuity in amblyopia therapy." *Invest Ophthal Vis Sci* 1986 Feb;**27**(2):273-7

There has been no simple clinical test which accurately predicts post-therapy visual acuity in amblyopic eyes. Since grating test patterns generally yield optimal visual acuity in amblyopic eyes, the authors sought to determine if pre-therapy laser interferometric grating visual acuity would predict conventional post-therapy visual acuity in functional amblyopia. In 90% of the patients who completed therapy, the pre-therapy laser visual acuity was within two lines of the post-therapy Snellen visual acuity. Thus, pre-therapy laser visual acuity is a good prognostic indicator of conventional post-therapy visual acuity in amblyopic eyes.

Sherman J Bass SJ
"VEPs in the prognosis of amblyopia therapy: a case report." *J Am Optom Assoc* 1983 Oct;**54**(10):915-8

Shippman S
"Video games and amblyopia treatment." *Am Orthop J* 1985;**35**:2-5

Sjostrand J
"Contrast sensitivity in children with strabismic and anisometropic amblyopia. A study of the effect of treatment." *Acta Ophthal* (Copenh) 1981 Feb;**59**(1):25-34

The contrast threshold of sinusoidal gratings of varying contrast and frequency was examined in children with amblyopia due to strabismus or anisometropia. In strabismic amblyopia the contrast sensitivity is depressed for only a limited band of high spatial frequencies. In anisometropic amblyopia depression of the contrast sensitivity function (CSF) was found over the whole frequency range. The CSF could not be predicted from the visual acuity measurements in amblyopic eyes due to strabismus, whereas a rough correlation was observed in anisometropia. During occlusion treatment of the dominant eye in anisometropia the visual acuity and the contrast sensitivity function of the amblyopic eye improved in parallel. The study indicates that the abnormalities in spatial vision are different in amblyopia due to strabismus or anisometropia during childhood. Determination of the contrast sensitivity function seems to be an additional tool besides acuity measurements to document changes of visual function during treatment of amblyopia.

Thomas C
"Considerations about amblyopia and its treatment." *Int Ophthal Clin* 1966 Fall;**6**(3):453-93

Tommila V
"A new chart for testing line acuity in amblyopia." *Acta Ophthal* (Copenh) 1972;**50**(4):565-9

Tommila V
"Treatment of amblyopia after loss of vision in the healthy eye." *Ophthal Ped Gen* 1982 Nov;**1**(3):177

Vaithilingam E
"Candle light fixation training in amblyopia." *Optician* 1982 May;**183** (4742):23

Veronneau-Troutman S
"The role of orthoptics in amblyopia and abnormal retinal correspondence." *Int Ophthal Clin* 1971 Winter;**11**(4):300-5

von Noorden GK
"Practical management of amblyopia." *Int Ophthal* 1983 Jan;**6**(1):7-12

Our knowledge on the mechanism of amblyopia has gained in recent years from concerted research efforts in basic science and clinical laboratories. Different clinical forms of amblyopia are reviewed and their diagnostic and therapeutic significance discussed. In spite of etiologic differences there are pathophysiological similarities. The value of the time proven constant occlusion treatment of the sound eye remains unchallenged even though minor modifications have become necessary to prevent occlusion amblyopia in infants and young children. Part-time occlusion and penalization are of ancillary value but cannot be considered equal in effectiveness to constant occlusion. Due to increasing public awareness there is a trend toward earlier diagnosis and thus successful treatment of amblyopia. However, more efforts must be directed toward including newborns in visual screening examinations.

von Noorden GK Springer F Romano P et al.
"Home therapy for amblyopia." *Am Orthopt J* 1970;**20**:46-50

Watson PG
"Clinical assessment of treatment of amblyopia." *Trans Ophthal Soc* 1979; **98**:201-8

The conventional method of treatment of amblyopia by fulltime occlusion of the normal eye has stood the test of time and is generally successful with 87% of patients achieving 20/40 or better if the patient has macular fixation. If fixation is eccentric, the percentage of successful cases drops off considerably. An alternative is described in which the normal eye was occluded for only 20 minutes a day during which time the patient had to concentrate on increasingly difficult tasks. An apparatus was designed by which high-contrast sharp-edged gratings could be rotated while the child concentrated on playing a game on a transparent sheet over the surface for a treatment session of seven minutes. Patterns of smaller intervals between the stripes were used as treatment progressed. Of those who had no previous occlusion therapy, 95% improved to 20/40 and 86% improved to 20/30. Of those with previous occlusion therapy, 77% improved to 20/40 and 55% to 20/30.

Weiss J
"Home exercises for amblyopia." *Arch Ophthal* 1973 Mar;**89**(3):235

Wick B Schor CM
"A comparison of the Snellen chart and the S-chart for visual acuity assessment in amblyopia." *J Am Optom Assoc* 1984 May;**55**(5):359-61

A standard Snellen chart and a chart that controls contour interaction effects and gives equal numbers of acuity trials for all letter sizes (the S-chart) were used to compare visual acuities for 30 amblyopic patients (17 with central fixation, 13 with eccentric fixation). No statistically significant difference appeared between S-chart and Snellen acuity in the acuity range 20/30 to 20/80. When amblyopic acuity was below 20/100, S-chart and Snellen acuities differed significantly.

Wilcox LM Jr Sokol S
"Changes in the binocular fixation patterns and the visually evoked potential in the treatment of esotropia with amblyopia." *Ophthalmology* 1980 Dec;**87**(12):1273-81

Using the binocular fixation pattern (BFP) and the visually evoked potential (VEP), thirteen amblyopic patients with comitant, non-accommodative esotropia with an angle range up to 30 delta were studied before and during occlusion therapy. A graded BFP with a stronger preferred fixation could be used to diagnose amblyopia. The BFP, however, showed no significant change with therapy despite improvement in acuity. In contrast, the VEP amplitudes, initially reduced in amblyopia, increased significantly as the vision responded to patching. The VEP was useful in diagnosing strabismic amblyopia and giving a predictive range of acuities.

Wilson G
"The practical management of suppression amblyopia." *Am Orthopt J* 1971; **21**:21-6

AFTER-IMAGE - TESTING AND TRAINING

Fletcher MC Abbott W Girard LJ et al.
"Biostatistical studies. Results of biostatistical study of the management of suppression amblyopia by intensive pleoptics versus conventional patching." *Am Orthopt J* 1969;**19**:8-30

Fletcher MC Silverman SJ Boyd J et al.
"Biostatistical studies. Comparison of the management of suppression amblyopia by conventional patching, intensive hospital pleoptics, and intermittent office pleoptics." *Am Orthopt J* 1969;**19**:40-7

Flynn JT
"Results with the use of pleoptics in the treatment of amblyopia." *South Med J* 1968 Nov;**61**(11):1169-71

Isutsui J
"Improvement of visual acuity by amobarbital combined with pleoptics." *Am J Ophthal* 1966 Dec;**62**(6):1171-6

Jenkins TC Pickwell LD Sheridan M
"After-image transfer--evaluation of short-term treatment." *Br J Physiol Opt* 1979;**33**(2):33-7

> The records of treatment by the after-image transfer method of 21 children, mainly with strabismus amblyopia, were examined to evaluate the acuity improvement in the short term. There was no significant improvement in 15 cases. In several other patients, an immediate response to the after-image method occurred, but these patients' binocular vision and acuity had deteriorated following previous improvement achieved by other orthoptic methods.

Koskela PU Hyvarinen L
"Contrast sensitivity in amblyopia III. Effect of occlusion." *Acta Ophthal* 1986 Aug;**64**(4):386-90

> Contrast sensitivity of 26 children (mean age 9 years) was measured using vertical gratings during the course of pleoptic treatment. A statistically highly significant improvement in the vision of amblyopic eyes occurred during intensive treatment in the hospital. Occlusion of the amblyopic eye (inverse occlusion) before the pleoptic treatment did not effect the function of the amblyopic eyes. During 8-week occlusion of the dominant eye (direct occlusion) after pleoptic treatment changes in the vision of the amblyopic eyes were statistically insignificant. In some patients there was change in contrast sensitivity without a corresponding change in visual acuity. The contrast sensitivity of the dominant eye decreased markedly during occlusion in 12 patients. After a continuous occlusion of only 2 weeks there was a statistically significant decrease at spatial frequency 6 c/deg. There was no simultaneous decrease of visual acuity; thus the change can be called 'hidden occlusion amblyopia'. An additional 8-week occlusion did not cause any statistically significant decrease in contrast sensitivity, but visual acuity of 2 patients decreased slightly, a sign of beginning occlusion amblyopia. The changes disappeared during 'Einschleich'-occlusion or penalization except in one child whose previously dominant eye became non-dominant and slightly amblyopic.

Malik SR Virdi PS Goel BK
"Follow-up results of occlusion and pleoptic treatment." *Acta Ophthal* (Copenh) 1975 Sep;**53**(4):620-6

Fifty cases of amblyopia, including some cases of eccentric fixation, which had previously been successfully treated by various therapies (conventional occlusion, red filter occlusion and pleoptics) were followed up from 12 to 68 months. Fifteen cases (30%) deteriorated to pretreatment level during the follow up. Deterioration was found to be greater in cases over the age of 15 years and in cases who did not follow the instructions given to them after cessation of therapy.

Sen DK
"Results of treatment of anisohypermetropic amblyopia without strabismus." *Br J Ophthal* 1982 Oct;**66**(10):680-4

One hundred and two patients with anisohypermetropic amblyopia without strabismus were studied. Microstrabismus was excluded by detailed orthoptic examinations including visuoscopy and Cuppers' bifoveal correspondence test. Treatment consisted in wearing correcting glasses and parttime or fulltime patching of the nonamblyopic eye. In patients with dense amblyopia patching of the amblyopic eye was done and Cuppers' afterimage method of pleoptic therapy was instituted as the initial procedure. When visual acuity improved sufficiently by this therapy, patching was used on the nonamblyopic eye. Sixty-five (63.7%) patients showed 2 lines or more improvement on the Snellen chart. Though young children (6 to 12 years) improved their visual acuity more often than those aged 13 to 20 years, a considerable number of patients (50.0%) in the older age group improved their visual acuity after therapy. The improvement in visual acuity was accompanied by improved stereoacuity in 49.0% of the patients. It is therefore suggested that every effort should be made to treat these patients even after the age of 12 years.

Veronneau-Troutman S Dayanoff SS Stohler T et al.
"Conventional occlusion vs. pleoptics in the treatment of amblyopia." *Am J Ophthal* 1974 Jul;**78**(1):117-20

Wick B
"A home pleoptic method." *Am J Optom Physiol Opt* 1976 Feb;**53**(2):81-4

A method of initiating an after-image in an amblyopic eye with eccentric fixation by using Haidinger's brush for fixation control is described. This technique makes home pleoptics possible.

OCCLUSION IN AMBLYOPIA

Abbas S
"Occlusion in the treatment of squint amblyopia." *Bull Ophthal Soc Egypt* 1972;**65**(69):213-7

Brown MH Edleman PM
"Conventional occlusion in the older amblyope." *Am Orthopt J* 1976; **26**:34-6

Burian HM
"Occlusion amblyopia and the development of eccentric fixation in occluded eyes." *Am J Ophthal* 1966 Nov;**62**(5):853-6

Catford GV
"Amblyopic occlusion: the results of treatment." *Trans Ophthal Soc UK* 1967;**87**:179-93

Ching FC Parks MM Friendly DS
"Practical management of amblyopia." *J Ped Ophthal Strab* 1986 Jan/Feb; **23**(1)

One hundred sixteen strabismus patients with amblyopia treated with initial fulltime or part-time conventional occlusion of the preferred eye followed when necessary with maintenance occlusion up to a maximum of nine years were studied. Based on the need for maintenance occlusion, patients were divided into a primary occlusion group, composed of patients who did not require maintenance occlusion and a maintenance group occlusion group, composed of patents who did require maintenance occlusion. The main difference between the two groups of patients was the degree of amblyopia at the onset of occlusion therapy, being significantly greater in the maintenace occlusion group. The maintenance occlusion group showed a significantly higher incidence of visual acuity regresssion when evaluated at ages 12 and 13 years. Occlusion therapy administered to strabismus patients in the manner described in this study resulted in significant visual improvement with a regression in visual acuity of no more than an average of one line on the Snellen chart.

Cibis L
"Penalization, treatment of ARC and amblyopia." *Am Orthopt J* 1975; **25**:79-84

Dalziel CC
"Strabismic amblyopia." *Am J Optom Physiol Opt* 1981 Sep;**58**(9):777-9

A 5-year-old male strabismic amblyope whose initial visual acuity in his amblyopic right eye was 6/30 (20/100) achieved a level of 6/6 (20/20) after 8 weeks of occasional occlusion therapy of the nonamblyopic eye.

Elmer J Fahmy YA Nyholm M et al.
"Extended wear soft contact lenses in the treatment of strabismic amblyopia." *Acta Ophthal* (Copenh) 1981 Aug;**59**(4):546-51

17 amblyopic children between 4 and 9 years were fitted with high power plus extended wear soft contact lenses (Scanlens 24 h, Duragel 75) for optical occlusion of strabismic amblyopia. Amblyopia and eccentric fixation responded quickly to treatment between 2 to 13 weeks. Only one patient failed to reach 6/9, and 11 patients achieved equal visual acuity. Out of 10 patients with eccentric fixation only two remained eccentric after treatment. The contact lenses were tolerated by the children. Among the problems, concerning the use of extended wear soft contact lenses, should

be mentioned fitting problems, deposits, loss of lenses (1 child needed 4 lenses) and occurrence of conjunctivitis (5 eyes). No major infections were seen. A one year followup showed that almost all the children needed renewed occlusion treatment. It is therefore recommended to continue with contact lens occlusion for at total period of 3 months.

Fletcher MC Abbott W Girard LJ et al.
"Biostatistical studies. Results of biostatistical study of the management of suppression amblyopia by intensive pleoptics versus conventional patching." *Am Orthopt J* 1969;**19**:8-30

Fletcher MC Silverman SJ Boyd J et al.
"Biostatistical studies. Comparison of the management of suppression amblyopia by conventional patching, intensive hospital pleoptics, and intermittent office pleoptics." *Am Orthopt J* 1969;**19**:40-7

Gokhale AM Gokhale SA
"Effect of occlusion treatment for amblyopia at various ages." *J All India Ophthal Soc* 1969 Dec;**17**(6):256-8

Gregersen E
"Occlusion treatment of squint amblyopia in young adults." *Acta Ophthal* 1966;**44**:166-8

Gregersen E Rindziunski E
"Conventional occlusion in the treatment of squint amblyopia." *Acta Ophthal* 1965;**43**:462-74

Iacobucci I
"Patching program for treatment of amblyopia." *J Ped Ophthal* 1977 Jan-Feb;**14**(1):7-11

Ingram RM Rogers S Walker C
"Occlusion and amblyopia." *Br Orthopt J* 1977;**34**:11-22

Amblyopia is reclassified into (a) primary, stimulus deprivation amblyopia, and (b) secondary amblyopia, which occurs only when a squint has been present for at least 4 months. Occlusion will not alter primary amblyopia, which usually presents after the "sensitive period", but will reduce secondary amblyopia.

Keiner EC
"Occlusion amblyopia." *Ophthalmologica* 1970;**161**(1):55-62

Koskela PU Hyvarinen L
"Contrast sensitivity in amblyopia III. Effect of occlusion." *Acta Ophthal* 1986 Aug;**64**(4):386-90

Contrast sensitivity of 26 children (mean age 9 years) was measured using vertical gratings during the course of pleoptic treatment. A statistically highly significant improvement in the vision of amblyopic eyes occurred during intensive treatment in the hospital. Occlusion of the amblyopic eye (inverse occlusion) before the pleoptic treatment did not effect the function of the amblyopic eyes. During 8-week occlusion of the dominant eye (direct occlusion) after pleoptic treatment changes in the vision of the amblyopic eyes were statistically insignificant. In some patients there was change in contrast sensitivity without a corresponding change in visual acuity. The contrast sensitivity of the dominant eye decreased markedly during occlusion in 12 patients. After a continuous occlusion of only 2 weeks there was a statistically significant decrease at spatial frequency 6

c/deg. There was no simultaneous decrease of visual acuity; thus the change can be called 'hidden occlusion amblyopia'. An additional 8-week occlusion did not cause any statistically significant decrease in contrast sensitivity, but visual acuity of 2 patients decreased slightly, a sign of beginning occlusion amblyopia. The changes disappeared during 'Einsch-leich'-occlusion or penalization except in one child whose previously dominant eye became non-dominant and slightly amblyopic.

Lennerstrand G Samuelsson B
"Amblyopia in 4-year-old children treated with grating stimulation and full time occlusion; a comparative study." *Br J Ophthal* 1983 Mar;**67**(3):181

We have compared the effects on visual acuity and binocular functions of grating stimulation (CAM therapy) and fulltime occlusion in 38 4-year-old, previously untreated amblyopic children. The patients were divided into subgroups with regard to amblyopia type and fixation pattern. We found that grating stimulation was slightly better than occlusion in improving visual acuity of anisometropic amblyopes with central fixation, but that both types of therapy were equally effective in strabismic amblyopia with central fixation and in amblyopia with eccentric fixation. However, maximal treatment effects were not reached with grating stimulation alone, as shown at followup after continued conventional therapy. Grating stimulation may be regarded as a valuable method at the initiation of treatment, particularly in anisometropic amblyopia, but it has to be supplemented with occlusion, which still must be regarded as the prime form of amblyopia therapy.

Lennerstrand G
"Recent advances in the management of amblyopia." *Int Rehabil Med* 1983;**5**(3):128-31

Methods of detection and treatment of amblyopia as a developmental visual defect are reviewed. Traditional occlusion therapy is compared with recent therapy techniques using square-wave grating patterns as stimuli to increase visual sensitivity. Both methods can help manage amblyopia particularly during stages of early visual development. It is found that the grating pattern stimuli are not in themselves therapeutic, but rather it is probably occlusion in combination with demanding visual tasks which help reduce amblyopia.

Malik SR Singh P Goel BK
"Long-term follow-up of red-filter treatment of amblyopia." *Br J Ophthal* 1972 Aug;**56**(8):613-6

Malik SR Virdi PS Goel BK
"Follow-up results of occlusion and pleoptic treatment." *Acta Ophthal* (Copenh) 1975 Sep;**53**(4):620-6

Fifty cases of amblyopia, including some cases of eccentric fixation, which had previously been successfully treated by various therapies (conventional occlusion, red filter occlusion and pleoptics) were followed up from 12 to 68 months. Fifteen cases (30%) deteriorated to pretreatment level during the follow up. Deterioration was found to be greater in cases over the age of 15 years and in cases who did not follow the instructions given to them after cessation of therapy.

Mitchell DE Howell ER Keith CG
"The effect of minimal occlusin therapy on binocular visual functions in amblyopia." *Invest Ophthal* 1983 Jun;**24**(6):778-781

The binocular visual functions of amblyopic children were studied during treatment involving brief weekly periods of occlusion of the unaffected eye while the child performed demanding visuomotor tasks against either a back-

ground of rotating gratings or a stationary uniform gray stimulus. The gains in stereoacuity were quite significant and in most cases more obvious than the rather small gains in letter visual acuity. On initial presentation only 21 of the 60 patients showed evidence of stereopsis and of these only seven possessed a stereoacuity of 100 secs or better. Following six treatment sessions the number of patients that demonstrated stereopsis increased to 36 of whom 17 possessed reasonably good stereo-acuity (100 secs or better). However, there was no difference in the degree of improvement exhibited by those patients that viewed rotating grating patterns during treatment and others from the control group that viewed the uniform gray stimulus. Thus, there was no evidence that any of the visual gains were enhanced or promoted by active visual stimulation of the amblyopic eye with rotating gratings during the brief periods of occlusion of the unaffected eye. Finally, a comparison of the scores of the children on various stereo-tests suggest that tests comprised of small figure elements that are present in high density may be best for screening purposes. On the other hand, for quantifying the stereoacuity of children known to possess abnormal binocular vision it may be more appropriate to employ tests that use large figure elements that provide strong fusion cues.

Nyman KG
"Controlled study comparing CAM treatment with occlusion therapy." *Br J Ophthal* 1983 Mar;**67**(3):178-79

A controlled study comparing CAM stimulation and occlusion therapies on 2 equally large, randomly allocated groups of 25 amblyopic children aged between 4 and 6 1/2 years was conducted. The main parameter of comparison was distant visual acuity. No significant difference was found between the 2 methods as regards mean improvement. By both methods 80% of the cases showed an improvement of at least 2 lines on the Snellan decimal steps chart. No case showed deterioration.

Scott WE Stratton VB Fabre J
"Full-time occlusion therapy for amblyopia." *Am Orthopt J* 1980;**30**: 125-30

Excellent results can occur in strabismic and anisometropic amblyopia if fulltime occlusion is carried out for their treatment. Although the results in treating deprivation amblyopia are not as good, they are influ-enced by organic factors, such as decreased visual acuity secondary to membranes, the problems of aphakia, cystoid macular edema, or irregular astigmatism secondary to corneal scars. It is also important to point out the successes of this treatment among the organic amblyopia group. Older children show a good gain in visual acuity in response to patching for a somewhat longer time than is necessary with younger children. The level of visual acuity when treatment is begun seems to have little effect on the final visual acuity attainable. About 50% to 66% of the patients will maintain their visual gain once occlusion is stopped.

Sen DK
"Results of treatment of anisohypermetropic amblyopia without strabismus." *Br J Ophthal* 1982 Oct;**66**(10):680-4

One hundred and two patients with anisohypermetropic amblyopia without strabismus were studied. Microstrabismus was excluded by detailed orthoptic examinations including visuoscopy and Cuppers' bifoveal correspondence test. Treatment consisted in wearing correcting glasses and parttime or fulltime patching of the nonamblyopic eye. In patients with dense amblyopia patching of the amblyopic eye was done and Cuppers' afterimage method of pleoptic therapy was instituted as the initial procedure. When visual acuity improved sufficiently by this therapy, patching was used on the nonamblyopic eye. Sixty-five (63.7%) patients showed 2 lines or more improvement on the Snellen chart. Though young children (6 to 12 years) improved their visual acuity more often than those aged 13 to 20 years, a considerable number of patients (50.0%) in the older age group improved

their visual acuity after therapy. The improvement in visual acuity was accompanied by improved stereoacuity in 49.0% of the patients. It is therefore suggested that every effort should be made to treat these patients even after the age of 12 years.

Thorn F Comerford JP
"Use of various measures of visual acuity and contrast sensitivity in the evaluation of monocular occlusion and active vision training of three adult amblyopes." *Am J Optom Physiol Opt* 1983 May;**60**(5):347-51

Three adult amblyopic patients who underwent vision training involving monocular occlusion of the nonamblyopic eye and stimulation of the amblyopic eye using simple fixation exercises and a spinning grating procedure were evaluated using five different types of acuity testing and two methods of contrast sensitivity. It was found that contrast sensitivity and isolated Landolt C acuity improved sooner and to a greater extent than the more complex visual acuity tasks. One patient who improved only on the simpler tasks complained that the enhanced contrast due to training made vision in that eye less acceptable because it was more confusing. The results show that multiple measures of visual acuity and contrast sensitivity are necessary to adequately monitor the effects of occlusion therapy.

Veronneau-Troutman S Dayanoff SS Stohler T et al.
"Conventional occlusion vs. pleoptics in the treatment of amblyopia." *Am J Ophthal* 1974 Jul;**78**(1):117-20

von Noorden GK Attiah F
"Alternating penalization in the prevention of amblyopia recurrence." *Am J Ophthal* 1986 Oct;**102**(4):473-5

Improved or normalized visual acuity in a formerly amblyopic eye has a tendency to deteriorate unless all amblyopiogenic factors are eliminated. As this can only be rarely accomplished, continued therapy to maintain optimal acuity in the formerly amblyopic eye is essential. Optic penalization of each eye by two pairs of spectacles, overcorrecting each eye on alternate days, has been effective in preserving visual acuity in 16 patients who had been successfully treated for strabismic or anisometropic amblyopia. This maintenance therapy is continued until the patient is no longer susceptible to a recurrence of amblyopia.

von Noorden GK Milam JB
"Penalization in the treatment of amblyopia." *Am J Ophthal* 1979 Sep;**88**:511-8

Penalization is a useful alternative to occlusion therapy in amblyopia of mild and moderate degrees and in preserving therapeutic gains made by previous occlusion treatment. Penalization at near,total, and alternating penalization are more valuable than penalization at distance. Because penalization does not prevent the development of visual deprivation amblyopia, unilateral atropine therapy must be used carefully in treating patients in an age group susceptible to occlusion amblyopia.

Watson PG
"Clinical assessment of treatment of amblyopia." *Trans Ophthal Soc* 1979;**98**:201-8

The conventional method of treatment of amblyopia by fulltime occlusion of the normal eye has stood the test of time and is generally successful with 87% of patients achieving 20/40 or better if the patient has macular fixation. If fixation is eccentric, the percentage of successful cases drops off considerably. An alternative is described in which the normal eye was occluded for only 20 minutes a day during which time the patient had to concentrate on increasingly difficult tasks. An apparatus was designed by which high-contrast sharp-edged gratings could be rotated while the child

concentrated on playing a game on a transparent sheet over the surface for a treatment session of seven minutes. Patterns of smaller intervals between the stripes were used as treatment progressed. Of those who had no previous occlusion therapy, 95% improved to 20/40 and 86% improved to 20/30. Of those with previous occlusion therapy, 77% improved to 20/40 and 55% to 20/30.

STRIPE THERAPY FOR AMBLYOPIA

Dalziel CC
"Amblyopia therapy by the Campbell-Hess technique." *Am J Optom Physiol Opt* 1980 May;**57**(5):280-3

Campbell and Hess developed a new technique for treating amblyopia. This technique involves stimulation of the amblyopic eye for precise time intervals with a graded series of contrast frequency gratings. Partial occlusion is used only during the treatment. Treating strabismic and anisometropic amblyopes by the Campbell-Hess amblyopia training technique produced an improvement of two lines on the acuity chart in six of 14 patients.

Doba AT
"Cambridge stimulator treatment for amblyopia." *Aust J Ophthal* 1981; **9**:121-7

Eighty consecutive patients with amblyopia ex anopsia were treated with the Cambridge Stimulator (Cam.). Each patient received an average of six, 15 minute treatment sessions at a frequency of 1-2 per week. Treatment was terminated after two consecutive treatments indicated no change in visual acuity. Sixty-nine patients were given minimal occlusion simultaneously with Cam. treatment. Of the first group, 47% achieved 6/12 or better visual acuity, although if the 14 eccentric fixators were excluded, 60% achieved 6/12 or better visual acuity. Of the second group, 91% improved to 6/12 or better visual acuity. This means the patients treated with full-time occlusion and Cam. showed an improvement of visual acuity of nearly twice the extent of those patients treated with minimal occlusion and Cam. over the same period of time.

Fricker SJ Kuperwaser MC Stromberg AE et al.
"Stripe therapy for amblyopia with a modified television game." *Arch Ophthal* 1981 Sep;**99**(9):1596-9

A variation of "stripe therapy" for amblyopia was evaluated with the use of 50 amblyopic subjects. The stimulus consisted of a television game that had been modified to allow simultaneous display of the game and moving stripe patterns. Subjects used their amblyopic eye to play the game for 20 min/wk. Some of the subjects played the game with the superimposed stripes, whereas a control group played the game without stripes. The exposure sessions continued for eight to 12 weeks, after which the subjects' visual acuities were measured for followup periods lasting up to a year. The visual acuities of many persons improved while they were playing the television game, but with wide variation in performance. During the six to 12 month followup period, the visual acuities of patients decreased from the levels attained during the exposure period. There seemed to be no major difference between the results from persons exposed to stripes and those from the control group, either during the exposure sessions or during the followup period.

Fricker SJ Kuperwaser MC Stromberg AE et all.
"Use of a video-game/stripe presentation for amblyopia therapy." *J Ped Ophthal Strab* 1981 Mar-Apr;**18**(2):11-6

A variation of "stripe therapy" for amblyopia is described, using a composite video presentation of a television game with horizontal or vertical moving stripe backgrounds. The initial study has been carried out with two groups of amblyopic subjects, one group exposed to stripe back-grounds while playing the television games, and a small control group playing the games without any striped backgrounds. A wide range of results was obtained over several weekly exposure sessions, from possibly significant improvement to essentially no change in visual acuity. The results obtained from the group exposed to striped backgrounds do not appear to be markedly better than those obtained from the control group.

Lennerstrand G Samuelsson B
"Amblyopia in 4-year-old children treated with grating stimulation and full time occlusion; a comparative study." *Br J Ophthal* 1983 Mar;**67**(3):181

We have compared the effects on visual acuity and binocular functions of grating stimulation (CAM therapy) and fulltime occlusion in 38 4-year-old, previously untreated amblyopic children. The patients were divided into subgroups with regard to amblyopia type and fixation pattern. We found that grating stimulation was slightly better than occlusion in improving visual acuity of anisometropic amblyopes with central fixation, but that both types of therapy were equally effective in strabismic amblyopia with central fixation and in amvlyopia with eccentric fixation. However, maximal treatment effects were not reached with grating stimulation alone, as shown at followup after continued conventional therapy. Grating stimulation may be regarded as a valuable method at the initiation of treatment, particularly in anisometropic amblyopia, but it has to be supplemented with occlusion, which still must be regarded as the prime form of amblyopia therapy.

Lennerstrand G
"Recent advances in the management of amblyopia." *Int Rehabil Med* 1983; **5**(3):128-31

Methods of detection and treatment of amblyopia as a developmental visual defect are reviewed. Traditional occlusion therapy is compared with recent therapy techniques using square-wave grating patterns as stimuli to increase visual sensitivity. Both methods can help manage amblyopia particularly during stages of early visual development. It is found that the grating pattern stimuli are not in themselves therapeutic, but rather it is probably occlusion in combination with demanding visual tasks which help reduce amblyopia.

Lennerstrand G Kvarnstrom G Lundh BL et al.
"Effects of grating stimulation on visual acuity in amblyopia." *Acta Ophthal* (Copenh) 1981 Apr;**59**(2):179-88

Thirty-one children with amblyopia were treated with CAM vision stimulation. Twenty-one of them had previously been treated with conventional methods but failed to improve further. The conventional therapy was continued during and after CAM. Grating stimulation was the first treatment attempted for the rest of the children. Most children in both groups showed improved distance visual acuity after CAM-treatment and no one suffered a loss. The average visual acuity improvement was the same in both groups of children and did not vary with age. The improvement amounted to about 50% of the visual acuity before CAM, irrespective of the pre-treatment acuity level. We conclude that CAM-stimulation can be useful in cases where occlusion or other amblyopia treatment has failed, but that some form of treatment must be continued if visual acuity is to be maintained after the CAM-treatment period.

Lundh BL Lennerstrand G
"Effects of amblyopia therapy on contrast sensitivity as reflected in the visuogram." *Acta Ophthal* (Copenh) 1983 Jun;**61**(3):431-46

A quantitative evaluation of the Cambridge amblyopia treatment on contrast sensitivity was performed for 2 groups, one comprising 11 children with strabismic amblyopia (S) and another of 10 children with combined strabismic and anisometropic amblyopia (S & A). Contrast sensitivity deficits were expressed in dB CSL (Contrast Seeing Level) in relation to normal sensitivity of the same age group and represented in the form of visuograms. Mean contrast sensitivity losses in dB CSL were estimated within the low, medium and high spatial frequency ranges, as well as over the total frequency band. On an average S & A amblyopia was found to affect contrast sensitivity of all spatial frequencies, while S amblyopia affected mainly the higher frequency band, but to a smaller extent. After therapy average

contrast sensitivity improved for both S and S & A groups, and reached the same, subnormal levels. The relation between highest resolvable spatial frequency (according to our method) and Snellen acuity was different for the 2 amblyopia groups. No correlation was found between improvements in contrast sensitivity and Snellen acuity, which is why both parameters should be estimated.

Nathanson DR Ciuffreda KJ
"Results of intensive CAM grating treatment in a strabismic amblyope." *Am J Optom Physiol Opt* 1982 Jun;**59**(6):511-4

CAM treatment was instituted for an 8-week period in a 10-year-old patient who failed to respond well to conventional amblyopia therapy. A small, consistent, statistically significant improvement in visual acuity was found. This improvement was attributed to a change in fixation locus and to practice effects, and not to spatial frequency/orientation-dependent "reactivation" of cortical neurons involved in the development of amblyopia.

Nyman KG
"Controlled study comparing CAM treatment with occlusion therapy." *Br J Ophthal* 1983 Mar;**67**(3):178-79

A controlled study comparing CAM stimulation and occlusion therapies on 2 equally large, randomly allocated groups of 25 amblyopic children aged between 4 and 6 1/2 years was conducted. The main parameter of comparison was distant visual acuity. No significant difference was found between the 2 methods as regards mean improvement. By both methods 80% of the cases showed an improvement of at least 2 lines on the Snellan decimal steps chart. No case showed deterioration.

Piggins D
"Wide field gratings--room to optimize amblyopia treatment?" - Comments upon Westall (1981). *Ophthalmic Physiol Opt* 1982;**2**(3):239-40

Schor C Wick B
"Rotating grating treatment of amblyopia with and without eccentric fixation." *J Am Optom Assoc* 1983 Jun;**54**(6):545-9

Treatment of amblyopia with and without eccentric fixation using short term occlusion and rotating gratings was analyzed in a controlled study. A control group (n = 18) viewed a blank rotating disc for 15 minutes once a week for ten weeks while the treatment group (n = 20) observed rotating gratings for the same time period. Both groups performed visually guided tasks to maintain treatment interest. Visual acuity was analyzed before and after each treatment session using a multiple Landolt ring chart. Data were gathered in a double masked manner. Analysis did not reveal a statistically significant improvement of visual acuity with rotating grating therapy for treating amblyopia with or without eccentric fixation.

Tarkkanen A
"Treatment of amblyopia using a CAM vision stimulator." *Ophthal Ped Gen* 1983 Feb;**2**(1):27

Thorn F Comerford JP
"Use of various measures of visual acuity and contrast sensitivity in the evaluation of monocular occlusion and active vision training of three adult amblyopes." *Am J Optom Physiol Opt* 1983 May;**60**(5):347-51

Three adult amblyopic patients who underwent vision training involving monocular occlusion of the nonamblyopic eye and stimulation of the amblyopic eye using simple fixation exercises and a spinning grating procedure were evaluated using five different types of acuity testing and two methods

of contrast sensitivity. It was found that contrast sensitivity and isolated Landolt C acuity improved sooner and to a greater extent than the more complex visual acuity tasks. One patient who improved only on the simpler tasks complained that the enhanced contrast due to training made vision in that eye less acceptable because it was more confusing. The results show that multiple measures of visual acuity and contrast sensitivity are necessary to adequately monitor the effects of occlusion therapy.

Watson PG
"Clinical assessment of treatment of amblyopia." *Trans Ophthal Soc* 1979; **98**:201-8

The conventional method of treatment of amblyopia by fulltime occlusion of the normal eye has stood the test of time and is generally successful with 87% of patients achieving 20/40 or better if the patient has macular fixation. If fixation is eccentric, the percentage of successful cases drops off considerably. An alternative is described in which the normal eye was occluded for only 20 minutes a day during which time the patient had to concentrate on increasingly difficult tasks. An apparatus was designed by which high-contrast sharp-edged gratings could be rotated while the child concentrated on playing a game on a transparent sheet over the surface for a treatment session of seven minutes. Patterns of smaller intervals between the stripes were used as treatment progressed. Of those who had no previous occlusion therapy, 95% improved to 20/40 and 86% improved to 20/30. Of those with previous occlusion therapy, 77% improved to 20/40 and 55% to 20/30.

Willshaw HE Malmheden A Clarke J et al.
"Experience with the CAM vision stimulator: preliminary report." *Br J Ophthal* 1980 May;**64**(5):339-41

Eighty-four children with at least 2 lines of amblyopia were treated with the CAM vision stimulator. 91% of the children who had received no previous amblyopia therapy showed improvement, 73% achieving 6/12 vision or better. Of children in whom previous occlusion therapy had failed 73.8% improved. The treatment appears to be effective, rapid, and well tolerated. Our initial impressions have been sufficiently favourable to stimulate further clinical evaluation.

Woo GC Dalziel CC
"A pilot study of contrast sensitivity assessment of the CAM treatment of amblyopia." *Acta Ophthal* (Copenh) 1981 Feb;**59**(1):35-7

Contrast thresholds of varying spatial frequencies were obtained on 3 amblyopic patients before and after the CAM treatment of amblyopia. Results of this study confirm previous findings that in the absence of change of visual acuity, contrast sensitivity function can be changed with the use of this technique. Improvement of contrast sensitivity can occur in older patients and that the sensitivity sometimes can deteriorate when treatment is stopped.

VDT's & VISION THERAPY

Allen MJ
"Accommodative rock via computer." *J Am Optom Assoc* 1988 Aug;**59**(8):610-3

A technique is presented for using a computer for the measurement as well as the training of accommodative facility. The testing and training are accomplished optically without any mechanically moving parts.

Cooper J
"Review of computerized orthoptics with specific regard to convergence insufficiency." *Am J Optom Physiol Opt* 1988 Jun;**65**(6):455-63

Traditional vision training or orthoptics has used line or contour targets to eliminate suppression and improve vergence performance. Manipulation of these stimuli is slow and arduous. Line stimuli require an experienced doctor/technician to interpret responses. Recently, automated vision training using microprocessor anaglyph stimuli, i.e., random dot stereo--grams (RDS), has been used in an operant conditioning paradigm. This technique has improved motivation of the patient, improved reliability, and provided standardization of therapy. In addition, the utilization of RDS associated with operant conditioning has been shown to improve vergence performance and to reduce asthenopia in the convergence insufficiency patient.

Cooper J Citron M
"Microcomputer produced anaglyphs for evaluation and therapy of binocular anomalies." *J Am Optom Assoc* 1983 Sep;**54**(9):785-8

An Atari 800 microprocessor with a color television monitor was used to produce red-green anaglyphs. These computer produced anaglyphs allow for rapid manipulation of vergence stimuli which allow the doctor greater control in diagnosis and therapy of binocular anomalies. Additionally, computer controlled stimuli allow for animation, and delivery of reinforcing aspects. The present paper describes a system in use.

Daum KM Rutstein RP Eskridge JB
"Efficacy of computerized vergence therapy." *Am J Optom Physiol Opt* 1987 Feb;**64**(2):83-9

The purpose of this study was to determine the efficacy of computerized fusional vergence therapy and the effect of two different vergence training velocities. Six subjects received positive vergence training using a slow vergence training rate (0.75 delta/s) and six subjects received positive vergence training using a fast vergence training rate (5.00 delta/s). Six subjects served as controls and did not receive therapy. The duration of therapy was 80 min over a period of 4 weeks. All training activities were monitored. All vergence evaluations were double masked. Subjects using a slow training rate showed significant increases in positive vergence ranges as measured with the major amblyoscope, whereas subjects training with fast rates did not. We conclude that vergence therapy using a computerized video display is an effective technique for increasing the amplitudes of positive fusional vergence and that slower rates are more productive than faster rates.

Fricker SJ Kuperwaser MC Stromberg AE et al.
"Stripe therapy for amblyopia with a modified television game." *Arch Ophthal* 1981 Sep;**99**(9):1596-9

A variation of "stripe therapy" for amblyopia was evaluated with the use of 50 amblyopic subjects. The stimulus consisted of a television game that had been modified to allow simultaneous display of the game and moving stripe

patterns. Subjects used their amblyopic eye to play the game for 20 min/wk. Some of the subjects played the game with the superimposed stripes, whereas a control group played the game without stripes. The exposure sessions continued for eight to 12 weeks, after which the subjects' visual acuities were measured for followup periods lasting up to a year. The visual acuities of many persons improved while they were playing the television game, but with wide variation in performance. During the six to 12 month followup period, the visual acuities of patients decreased from the levels attained during the exposure period. There seemed to be no major difference between the results from persons exposed to stripes and those from the control group, either during the exposure sessions or during the follow-up period.

Fricker SJ Kuperwaser MC Stromberg AE et al.
"Use of a video-game/stripe presentation for amblyopia therapy." *J Ped Ophthal Strab* 1981 Mar-Apr;**18**(2):11-6

A variation of "stripe therapy" for amblyopia is described, using a composite video presentation of a television game with horizontal or vertical moving stripe backgrounds. The initial study has been carried out with two groups of amblyopic subjects, one group exposed to stripe backgrounds while playing the television games, and a small control group playing the games without any striped backgrounds. A wide range of results was obtained over several weekly exposure sessions, from possibly significant improvement to essentially no change in visual acuity. The results obtained from the group exposed to striped backgrounds do not appear to be markedly better than those obtained from the control group.

Groffman SG Press LJ
"Computerized perceptual therapy programs - Part I." *Research Reports and Special Articles* Optometric Extension Program 1989 Aug;**61**(11):387

Groffman SG Press LJ
"Computerized perceptual therapy programs - Part II." *Research Reports and Special Articles* Optometric Extension Program 1989 Sep;**61**(12):423

Maino DM
"Microcomputer mediated visual developmental and perceptual therapy." *J Am Optom Assoc* 1985 Jan;**56**(1):45-8

There are currently few computer programs written by optometrists for optometrists to be utilized as methods of treatment for those patients with deficits in the areas of developmental vision and perception. This paper reviews educational and commercially available programs that with certain modifications may meet the therapeutic needs of our patients.

Major D Pirotte P
"Duction training with a microcomputer: a comparative study." *Optometric Extension Program* 1985 Dec;**58**(3):1

Saladin JJ Bohman CE
"Anaglyphic T.V. ping pong antisuppression trainer." *J Am Optom Assoc* 1977 Jul;**48**(7):929-32

Orthoptic therapy often entails the repetitive usage of detailed and complicated training procedures. Amblyopia and antisuppression therapy in particular may require weeks or months of training. A multipurpose training device has been constructed from commercially available components and promises to maintain a high level of patient interest and cooperation throughout the training procedure.

Savedoff L Weiss J Sturr J et al.
"The effects of "videogame therapy" on children with oculomotor dysfunction." *Journal of Optometric Vision Development* 1985 Jun; **16**(2)15-17

This study evaluated the effects of "videogame therapy" on children with oculomotor dysfunction. Twelve subjects, aged 7-12, served in experimental or control conditions that evaluated performance on the King Devick Saccadic Test (KDST) before and after videogame intervention. There were no improvements in performance suggesting that "videogame therapy" would not be an adequate substitute for conventional vision training.

Shippman S
"Video games and amblyopia treatment." *Am Orthop J* 1985;**35**:2-5

Somers WW Happel AW Phillips JD
"Use of a personal microcomputer for orthoptic therapy." *J Am Optom Assoc* 1984 Apr;**55**(4):262-7

Christenson GN Winkelstein AM
"Visual skills of athletes versus nonathletes: development of a sports vision testing battery." *J Am Optom Assoc* 1988 Sep;**59**(9):666-75

> The field of sports vision has a fundamental premise that athletes require superior visual abilities to succeed in their sporting activity. This study takes a scientific look at what appear to be sports-related visual abilities using a clinical battery of vision tests to compare the visual performances of athletes to nonathletes. Significantly better visual performances were found to exist in the athletic population for certain visual skills: vergence facility, saccades, visual reaction time, peripheral awareness and near point of convergence. The tests for accommodative facility, visual proaction time, span of recognition distance phoria and distance stereopsis did not yield a statistically significant difference between the groups. These results provide a foundation for the development of a research-based sports vision testing battery.

Granet DB
"Objectivity in sports vision testing." *Int Ophthal Clin* 1988 Fall; **28**(3):197-8

Hoffman LG Polan G Powell J
"The relationship of contrast sensitivity functions to sports vision." *J Am Optom Assoc* 1984 Oct;**55**(10):747-52

> Contrast sensitivity, a more recent test of visual function, has never been studied in its relationship to sports vision. The hypothesis that contrast sensitivity functions among college varsity level baseball players significantly differs from that of a random sample of optometry students was tested using Arden grating plates. A statis-tically significant difference was found at the 98 percent confidence level, demonstrating that in this study, a sample of college varsity level baseball players have higher level contrast sensitivity func-tions than those of a randomly selected sample of Southern California College of Optometry students.

Kofsky M
"Sports vision visual training and experimental program with Australian Institute of Sport baskerball players." *S Afr Optom* 1988 Mar;**47**(1):39

Ommen DV
"Sports vision and your practice." Optometric Extension Program, 1984 Mar;**56**(6):57

Pepper RC
"Sports vision therapy." *Research Reports and Special Articles,* Optometric Extension Program 1987 Jun;**59**(9):485

Pepper RC Wyckoff WL
"Stress training for improving athletic performance." *Research Reports and Special Articles,* Optometric Extension Program 1984 Jan;**56**(4):49

Pickwell D
"Binocular vision in sport, guidance for optometrists." *Opt Today* 1986 Apr;**26**(8):240

Prasnikar AJ
"Sports vision and the high school coach." *Research Reports & Special Articles,* Optometric Extension Program 1982 Nov;**55**(2):45

Reichow AW Stern NS
"Sports vision." Optometric Extension Program, Oct 1986-Aug 1987;**59**(1-11)

Runninger J
"'Eyes on the ball' an oversimplification." *J Am Optom Assoc* 1980 Jul;**51**(7):667-70

The familiar sports axiom "Keep your eyes on the ball" is an over-simplification of what can be a difficult process. In addition to enhancing the visual performance of athletes via spectacles, contact lenses, and vision therapy, optometric advice on how to best utilize vision for better performance can be invaluable to coaches and athletes.

Schwartz B
"Optometrists may give athletes winning edge with eye training." *Opt Times* 1986 Apr;**4**(4):5

Sewall LP Reeve TG Day RA
"Effect of concurrent visual feedback on acquisition of a weightlifting skill." *Percept Mot Skills* 1988 Dec;**67**(3):715-8

Practice in front of a mirror is a common procedure for activities such as dance, gymnastics, and other sports. The purpose of this study was to examine the effect that performing with concurrent visual feedback from a mirror had on the acquisition of the power clean movement. 18 college-age males who had no prior experience with the power clean movement served as subjects who were assigned to one of two groups. One group had use of a mirror during the practice trials and the other practiced without the mirror. All subjects viewed an instructional videotape and had practice trials. All subjects were evaluated for proper technique on a pretest, a posttest without the mirror, and a post-test with the mirror. Analysis showed a significant difference between pre- and post-test performances for both groups and a significant difference between groups on the posttest performances with the mirror. Evidently the videotaped instruction was sufficient to allow both groups to improve in performance of the power clean. Differences in posttest performances with the mirror reflected the type of feedback (with or without the mirror) available during training.

Shankman AL
"Vision enhancement training and mind-body philosophy." Optometric Extension Program Oct 1985-Sep 1986;**58**(1-12)

Sherman A
"A method of evaluating eye hand coordination and visual reaction time in athletes." *J Am Optom Assoc* 1983 Sep;**54**(9):801-2

The author has developed an innovative method of determining athletic proficiency using the factors of eye-hand coordination, visual pre-action and visual reaction time.

Sherman A
"Overview of research information regarding vision and sports." *J Am Optom Assoc* 1980 Jul;**51**(7):661-6

Shore KD
"Spatial localization techniques can help improve sports vision." *Opt Times* 1986 Mar;**4**(3):2

Stein RM Squires G Pashby T et al.
"Can vision training improve athletic performance?" [editorial] *Can J Ophthal* 1989 Apr;**24**(3):105-7.

Stein RM Squires G Pashby T et al.
"Can vision training improve athletic performance?" [letter] *Can J Ophthal* 1989 Oct;**24**(6):295

Stine CD Arterburn MR Stern NS
"Vision and sports: a review of the literature." *J Am Optom Assoc* 1982 Aug;**53**(8):627-33

The basis for training visual abilities to enhance sports performance is explored. Optometric intervention in sports assumes the following statements to be true: 1. Athletes have better visual abilities than non-athletes and better athletes have better visual abilities than the poorer athletes, 2. Visual abilities are trainable, and 3. Visual training is transferable to the performance of the athlete. The literature demonstrates that athletes have better visual abilities than non-athletes. Studies have shown this to be true in the following areas of vision: Larger extent of visual fields, larger fields of recognition (peripheral acuity), larger motion perception fields, lower amounts of heterophoria at near and far, more consistent simultaneous vision, more accurate depth perception, better dynamic visual acuity, and better ocular motilities. The literature also shows that all of the above skills are trainable. Two studies are cited that support the belief that visual training is transferable to athletic performance but they suffer from inadequate experimental design.

Teig DS
"Sports vision care: the eyes have it!" *J Am Optom Assoc* 1980 Jul;**51**(7):671-4

A team approach directed at a total evaluation of an athlete's visual needs is essential to proper sports vision care. Consideration of the visual requirements of the athlete through observation of on-the-field performance enables the sports vision specialist to adapt specific therapy procedures that are pertinent to the player's overall athletic success.

BIOFEEDBACK APPLICATIONS

Afanador AJ
"Auditory biofeedback and intermittent exotropia." *J Am Optom Assoc* 1982 Jun;**53**(6):481-3

Ciuffreda KJ
"Auditory biofeedback as a potentially important tool in the treatment of nystagmus." *J Am Optom Assoc* 1980 Jun;**51**(6):615-7

Ciuffreda KJ Goldrich S
"Auditory feedback as a potentially important new tool in the treatment of nystagmus." *J Am Opt Assoc* 1980 Nov;**51**(11):1037-9

Ciuffreda KJ Goldrich SG
"Oculomotor biofeedback therapy." *Int Rehabil Med* 1983;**5**(3):111-7

> Biofeedback therapy refers to the process of gaining voluntary control over some bodily function by the immediate use of information regarding its physiological state. In this paper we review the use of oculomotor biofeedback therapy in three common ocular disorders: nystagmus, strabismus, and amblyopia. Experimental and clinical test results have been encouraging. We believe oculomotor biofeedback therapy should be attempted, either alone or in conjunction with orthoptic and/surgical procedures, in these and other ocular disorders manifesting an abnormal oculomotor component.

Ciufredda KJ Goldrich SG Neary C
"Use of eye movement auditory feedback in the control of nystagmus." *Am J Optom Physiol Opt* 1982 May;**59**(5):396-409

> Eye movement auditory biofeedback was used in weekly training sessions to control nystagmus in five adult patients. Within the 1st hour of training, all patients were able to reduce nystagmus. Average maximum group reduction of nystagmus amplitude, peak slow-phase velocity, and frequency achieved during training with auditory biofeedback was 82, 86, and 34%, respectively. At periodic intervals during training, audio information was withheld and patients were able to maintain reduced nystagmus for several minutes. In addtion patients were able to reduce nystagmus upon command without audio cues but with conscious effort while engaging in conversation and other tasks with the experimenters. Visual acuity improvement with consicious patient effort to control nystagmus but without auditory biofeedback averaged 10% Snell-Sterling. One of two patients who returned for post-training reevaluation was able to reduce his nystagmus quickly without auditory biofeedback to 50% of the pretraining level, and both patients were able with the aid of auditory cues to reduce their nystagmus rapidly to the level achieved during training. In addition to the improvement in vision, cosmetic and psychological benefits accrued. Eye movement auditory biofeedback should be considered in the treatment of nystagmus, either alone or in conjuction with orthoptic and/or surgical procedures.

Giddings JW Lanyon RI
"Effect of reinforcement of visual acuity in myopic adults." *Am J Optom Physiol Opt* 1973 Jun;**51**:181-6

> In two experiments, attempts were made to improve visual acuity through reinforcement. In Experiment I, four myopic subjects were given five blocks of 24 trials in a conditioning task. The target stimuli were slides of Landolt rings, with 14 different sizes (increasing on a logarithmic scale) and 12 different stimuli representing each size. Trial blocks of contingent social-approval for a correct response were alternated with noncontingent

blocks in which approval was delivered randomly. Results permitted the inference that contingent approval resulted in increased acuity. In Experiment II, essentially the same task was used to compare the performance of three groups of subjects (each N=20): contingent reinforcement, noncon-tingent response, and no-response control. Results showed a nonsignificant increase in acuity and a significant decrease in refractive error. Possible directions for further research are discussed, and ethical considerations are noted.

Goldrich SG
"Oculomotor biofeedback therapy for exotropia." *Am J Optom Physiol Opt* 1982 Apr;**59**(4):306-17

Twelve exotropes of various types received oculomotor biofeedback therapy at State College of New York (SUNY) University Optometric Center. Feedback of a variable pitch tone which reflected changes in ocular vergence reinforced motor control of eye posture. Patients were trained to achieve and sustain alignment in a variety of viewing situations. The six intermittent exotropes in the study who did not have amblyopia or prior history of unsuccessful surgical or orthoptic therapy achieved the highest recovery rating after training. The amblyope and those who had orthoptic training learned to voluntarily correct their eye position, although they did not achieve as acute a sensitivity to loss of alignment as did the others. Therapy restored eye control at near in a young constant exotrope whose condition resulted from severe neurological dysfunction. A constant post-surgical exotrope who had no ability for sensory fusion made little progress. Advantages of oculomotor biofeedback therapy are shorter treatment time, elimination of lengthy home training exercises, and enhanced patient motivation.

Hirons R Yolton RL
"Biofeedback treatment of strabismus: case studies." *J Am Optom Assoc* 1978 Aug;**49**(8):875-82

This project demonstrates the use of neuromuscular reeducation biofeedback as a treatment for strabismus. Of the three subjects treated, an exotrope and an esotrope were cured according to predefined criteria and an exotrope with a dense monocular cataract was improved. Treatment consisted of monitoring eye positions using infrared sensors and feeding back information on relative ocular deviations coded in the form of a tone.

Letourneau JE Giroux R
"Using biofeedback in an exotropic aphake." *J Am Optom Assoc* 1984 Dec; **55**(12):909-10

Biofeedback has been used to achieve control over vergence, version, and torsion movements, nystagmus, amblyopia, strabismus, accommodation, and blepharospasm. This case report describes the use of auditory biofeedback and operant conditioning for cosmetic improvement in an aphakic patient.

Rosen RC Schiffman HR Meyers H
"Behavioral treatment of myopia: refractive error and acuity changes in relation to axial length and intraocular pressure." *Am J Optom Physiol Opt* 1984 Feb;**61**(2):101-5

A controlled outcome study on the effects of behavioral training on several measures of visual performance was conducted. Twenty-nine myopic subjects received complete optometric evaluations before being randomly assigned to one of three experimental groups. One treatment group received a behavioral training program with a feedback and reward component, another group received a behavioral training without feedback and reward, and the third group was the no-treatment control group. In addition to measuring the effects of training on visual acuity and refraction, independent measures of axial length and intraocular pressure (IOP) were obtained for all subjects before and after treatment. An analysis of covariance indicated