ORTHOPTIC TREATMENT OF STRABISMUS*

A STUDY OF ONE HUNDRED FORTY NINE NON-OPERATED, UNSELECTED, CONCOMITANT STRABISMUS PATIENTS COMPLETING ORTHOPTIC TRAINING AT THE OPTOMETRIC CENTER OF NEW YORK.

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INTRODUCTION

Orthoptics, the non-surgical method of strabismus therapy, has long been recognized as both a specific remedy in itself, for selected types of strabismus,[1-10] and an important adjunct to other methods of squint treatment (e.g., refraction and surgery).[11-17]

Much has been written on specific orthoptic techniques for altering the binocular neuromuscular mechanism.[18-23] and the ophthalmic literature abounds with complete case reports of orthoptically cured strabismics.[24-30]

The great controversy yet remaining in the field of orthoptics centers about the question, "How good a general strabismus remedy is orthoptics (together with refraction) in curing large numbers of unselected, concomitant strabismics?" This study is an attempt to begin to answer that question.

A review by the author of twenty-five years of the American and British optometric and ophthalmological literature has uncovered fifteen references to the relative success of orthoptics in binocularly rehabilitating large numbers of strabismics. The references are presented in the chronological order of their publication, accompanied by brief remarks about each:

1. Cantonnet and Filliozat[3] (1932) in the introduction of their classic volume on the orthoptic rehabilitation of strabismus, estimate that 70 per cent of all strabismics can be re-educated, usually in a period of from six to fifteen months.
2. Hicks and Hosford[31] (1935) after nine months of training with 32 patients, three to thirteen years of age, resulting in 5 cures (16%), felt that orthoptics was of little value except in conjunction with surgery.
3. Feldman[9] (1935) cites results of 87 cases after one year's work. Cures, or almost cures were obtained for 25 patients (29%), 25 showed little improvement or were dropped by the clinic, and 37 dropped out of their own accord.
4. Guibor[32] (1936) states that in his experience, refraction, atropine, and

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occlusion cure 30 per cent of strabismics. Adding fusion training raises the rate of cure to 50 per cent.

5. Post[36] (1936) feels that orthoptic training adds an additional 20 to 30 per cent to the good results obtainable merely by suitable spectacles.

6. Law[37] (1938), deprecating the work of the "orthoptic department presided over by a medically unqualified certified orthoptist" at the Paddington Green Hospital, states that of 91 patients seen, 30 were cured with spectacles alone; 27 (30%) patients were cured by orthoptics, occlusion, and spectacles; and the rest could not be cured.

7. Burri[38] (1940) reports on two samples of strabismus patients trained at once weekly sessions, with no homework assigned. The results in the first group of 115 patients were: 25 cures (22%), 40 improved with orthoptics, one was cured with spectacles, and 50 patients could not be helped orthoptically. The second sample showing better results had a total of 64 patients; 20 were orthoptic cures (31%), 22 improved with orthoptics alone, and 22 were orthoptic failures.

8. Nugent[39] (1940), referring to 43 orthoptic cures out of 81 patients trained, concludes that "about 50% of all cases of strabismus can be cured with refraction, occlusion, atropine and orthoptics."

9. Smith[26] (1943) commenting on Nugent's paper, agrees with the efficacy of orthoptics as a specific, sole remedy, but, on the basis of his clinical experience, thinks that a 70 per cent figure is closer to the rate of cure. In 1950[6] he raised his estimate and stated that at least 75 per cent of non-paralytic strabismus can be corrected entirely by orthoptic treatment and spectacles.

10. Gillan[40] (1945), describing his orthoptic work with 63 children, five to twelve years of age, treated for periods ranging from one month to sixteen months, finds 23 (37%) orthoptic cures, 25 almost straight (five degrees or less residual deviation) and 15 failures. Optimistic about his orthoptic results, he states that deviations of twenty-five degrees or less may be treated orthoptically with success.

11. Giles[5] (1949) reports on two studies. One by Hogg shows 82 per cent success in a strictly selected sample of 50 patients, taken from an analysis of 116 orthoptic records. Gray and Hallmark show 92.7 per cent success in another sample of 41 five to fourteen year olds, again strictly selected as to prognosis from a larger group of 82 records.

12. da Luz[41] (1949) reports the results of 63 patients completing training, out of an original sample of 143. By orthoptic training alone, 21 (33%) were straightened, 12 were given good binocular vision with training and surgery, and the remaining 30 did not result in straight fusing eyes with a combination of training, refraction, and/or surgery.

13. Castanera[42] (1951), reporting on 160 patients between the ages of three and ten years, found that 52 (33%) were cured with orthoptic treatment alone, 85 recovered normal binocular perception with training and surgery, and 23 were classed as failures.

14. Douglas[43] (1952), after a review of the literature and a denunciation of the work thus far published to support the efficacy of orthoptics as either a specific, or ancillary procedure in the treatment of strabismus, studies the results of two hospital orthoptic departments. On the basis of 203 patients, he deduces that only 42 (22%) were helped by orthoptic treatment. His conclusion is that an orthoptics department "can be profitably used for diagnosis, supervision of occlusion, and to maintain a closer liaison with the patient and his parents," all secondary to surgical treatment.

15. Jonkers[44] (1954) reports on his results obtained on 91 strabismic patients. Orthoptic therapy alone brought 31 (35%) to a functional cure, 23 were functional cures with orthoptic training and surgery combined, and 37 were not cured.

In perspective, the papers on the efficacy of orthoptics as a squint cure just reviewed, all have one or more of five basic faults. The present study has attempted to avoid all five. They are:

A. Orthoptics was viewed as a secondary method of cure, to be used after surgery had *not* given the desired results. As a consequence, orthoptic and surgical results were reported so intertwined, that it was

impossible to judge accurately the part played by orthoptics in the final results.

B. No satisfactory specific and detailed definition of "cure" or results was formulated, so that there could be no general agreement as to the results obtained in a specific case.

C. The training work unfortunately was performed largely, in the words of Law,[34] by "medically unqualified certified orthoptists," who, quoting Douglas,[40] "it must be remembered, have had only a minimum of scientific training."

D. Some of the quoted figures for rates of cure, were rough estimates based on the recollection of the clinical experience of that author, and not based on a strict analysis or study.

E. In several of the papers, too strict a selection policy in reporting cases has obscured the true value of orthoptics alone as a specific strabismus remedy for large numbers of strabismics.

One of the chief difficulties of the previous papers mentioned has been the lack of agreement on specific criteria for evaluating success in treating strabismus, and the classification of the results obtained in each case. A study at the University of California Optometry School, by Flom[42] (1958), has set forth five categories of results in some detail. His classification was found to be satisfactory, with the single exception that no requirement for satisfactory binocular motility in all positions of gaze, was stated for the class of "functional cure." With this single addition, the present study will utilize Flom's criteria as hereafter quoted:

> The criteria for a "functional cure" of strabismus, as adopted at the beginning of the U.C. study, were as follows: Clear, comfortable, single binocular vision must be present at all distances up to the near point of convergence, which is normal itself; there must be stereopsis and normal ranges of motor fusion; an occasional turning of the eyes may occur (up to 1% of the time) providing diplopia is experienced whenever this happens; correction lenses and small amounts of prism (up to 5Δ) may be worn if necessary.
>
> A second set of criteria was adopted for the category of "almost cured." In this category a patient may lack stereopsis, may exhibit strabismus with diplopia up to 5% of the time, and may need larger amounts of prism to maintain comfortable binocular vision. In all other respects the patient must meet the criteria for "functional cure."
>
> Categories of "moderate improvement" and "slight improvement" were adopted for those patients for whom the main improvement was respectively, in more than one, or in only one, of the defects associated with the strabismus. The category of "no improvement" was adopted for those patients for whom there was no significant improvement in the strabismus or its associated defects.

ORTHOPTICS PROCEDURE AT THE OPTOMETRIC CENTER

Before entering upon the specifics of the present study, a general statement as to the procedure followed for orthoptic patients at the Optometric Center is in order.

1. Every strabismus patient undergoes an initial refraction, visual analysis, and orthoptic workup.

2. The information obtained from the workup and analysis is discussed with the patient and/or parent, and a prognosis is given, as well as an estimate of the approximate length of time required for the desired results to be obtained.

3. The usual frequency of visit is twice weekly for three-quarters of an hour periods. Group sessions are conducted with three or four patients being seen simultaneously. Different optometrists attend the patient on each of the two training days. In addition, up to one half hour daily home sessions are prescribed (other than occlusion, which may be constant for as long as two week periods).

4. The staff holds monthly seminars to discuss the patients under current treatment.

5. Before dismissal, the patient is sent back for refraction and final analysis. After terminating regular clinic training, the patient is followed up at bimonthly recheck visits for at least one year, to ascertain that the newly acquired binocular status is retained permanently and with comfort.

6. In the hope that others may wish to repeat our work, the types of therapy used at the Optometric Center have been broken down (for the purposes of simplification) into six classifications, each group being accompanied by the instrumentation used to carry out that particular classification of therapy.

A. HAND EYE COORDINATION
   1. Cheiroscope (both stereoscope and Maddox types)
   2. Rotoscope with pointers
   3. Telebinocular with pointers (BU and AN series)
   4. Brock posture box
   5. Stereofly
   6. Pigeon-Cantonnet stereoscope
   7. Brock glass and light
   8. Seizel Fusor
   9. String pushouts and pushups
   10. Basic Stereomotivator, near viewer and pointer

B. ACCOMMODATIVE-CONVERGENCE TRAINING
   1. Prism reader
   2. Tele-binocular with tromboning
   3. Teleye-trainer with accommodative rock
   4. Binocular rock "flipper"
   5. Omnitrainer
   6. Stereo-Disparator
   7. Rotoscope with auxiliary lenses
   8. Troposcope with auxiliary lenses

C. MOTILITY TRAINING
   1. Arneson Squint Korrector
   2. Rotoscope
   3. Saccadic board
   4. Calisthenic series

5. Pursuit movements
6. Myoculator
7. Kratoculator

D. OCCLUSION
1. Part-time total occlusion
2. Total elasto-plast occlusion
3. Binasal or bitemporal occluder
4. Frosted glass over the better eye
5. Colored lens over the amblyopic eye
6. Stippled nail polish on the patient's lens

E. PRESCRIPTION
1. Distance Correction only
   A. Undercorrection
   B. Overcorrection
   C. Exact correction
   D. With vertical and/or horizontal prism
   E. For constant or intermittent wear
2. Near Correction only
   A. Undercorrection
   B. Overcorrection
   C. Exact correction
   D. With vertical and/or horizontal prism
3. Bifocal Prescription
   A. For constant wear
   B. With vertical and/or horizontal prism

F. FUSION
A. Space
   1. B.S.M. intermediate and near viewers
   2. Arneson Squint Korrector
   3. Remy Separator
   4. Set of loose square prisms
   5. Brock Anaglyph Wall Rings
   6. Dynascope
   7. Bielschowsky after-image test
   8. Brock after-image transfer test
   9. Brock posture box
   10. Red-Green glasses and light or T.V. screen
   11. String vergence
   12. Topper polaroid set
   13. Straw and tube
   14. Phorometer
   15. Kratoculator and red-green glasses
   16. Mirror training
   17. Bar reading
   18. Myoculator and red-green glasses
   19. Physiological diplopia training

B. Instrument
   1. Troposcope
   2. Rotoscope
   3. Omnitrainer
   4. Stereo Disparator
   5. Kratometer
   6. Stereoscope
   7. Prism reader
   8. Teleye-trainer
   9. Diploscope
   10. Cheiroscope
   11. Telebinocular

CRITERIA OF CASE SELECTION FOR THE STUDY

A total of 517 patients were seen by the orthoptic department

during the four years June, 1956, to June, 1960. Of these, 284 had strabismus, the others having non-squint binocular asthenopic and reading problems. In order to guage the value of orthoptics as a remedial measure in the correction of squint, the following criteria for inclusion of a patient in the study were formulated:

1. The patient had strabismus, i.e., manifested a binocular deviation, either constant, intermittent, or periodic.
2. The deviation was not capable of correction with lenses.
3. No surgical intervention had previously taken place.
4. There was no evidence of paresis or paralysis in the primary or any secondary position of gaze.
5. The patient attended at least eight sessions of orthoptic training (one month).
6. The patient terminated regular clinical training. If the patient satisfied the above six criteria, he was included in the study, with no prior knowledge of results.

149 patients met the criteria and were included in the study.

135 were not included for the following reasons: (1) 19 were post-surgical cases with residual angles, undergoing training to fully correct the squint. (2) Eight had non-comitant squints with either paresis or paralysis of one or more of the extra-ocular muscles. (3) Nine were accommodative esotropias which were fully corrected with spectacles and several training sessions. (4) 48 dropped out of training in seven or fewer visits (twenty-one dropped out after the first workup visit). (5) 51 were still undergoing training.

TABULATION OF THE CASES

The total sample of 149 cases were tabulated under twenty-six items considered by the author to be of major importance in classifying and categorizing the squint, and toward judging the final results obtained in each case:*

1. Case number.
2. Sex of each patient, included to see if a sex difference exists in the training results obtained, or in the types of squint encountered.
3. Date of the start of training, recorded in terms of month and year. This item was included to judge whether the quality of results improved over the four-year period.
4. Age of the patient at the start of training, to the nearest half-year.
5. Length of time the patient has had the squint condition, to the nearest half year. This was an estimate by the parent or patient and was corroborated occasionally by photographs.
6. Variety of squint fixation in two categories: alternating and unilateral. Unilateral recorded in terms of the deviating eye R or L.
7. Direction of deviation in four categories: Exo, Eso, Hyper-exo, and Hyper-

*The complete tabulation is on file at the Optometric Center of New York.

eso. To be considered a hyper case the vertical component must have measured two prism diopters or more.

8. Frequency of appearance of the deviation in three categories: Constant, Intermittent (occasionally straight), and Periodic (occurring either only upon near fixation X^N or only at distance fixation X^D.

9. Presence of an accommodative component. That is, whether the necessary refractive correction helped to reduce the strabismic deviation at distance.

10. The magnitude of the squint deviation, measured in prism diopters. Determined with fixation at twenty feet, while the patient was wearing the distance correction, by the amount of loose prism necessary to neutralize the movement on the alternate cover test. The amount was tabulated in one of three groups: 0 to 15Δ, 16 to 30Δ, 31 to 60Δ.

11. Five tests of binocular correspondence were used throughout the four-year period of the study. Several additional tests have been utilized recently, but have not been included in this study. The five tests routinely used are listed below. The results of the tests were recorded as: N meaning normal correspondence, S meaning suppression of the image of one eye, A meaning absence of binocular correspondence, and a blank indicating that the test was not performed or could not be interpreted by the patient.

A. Troposcope: Lack of fusion at the objective angle, measured while the patient was wearing the distance correction, by neutralizing the eye fixation movement on alternate flash, was held to indicate lack of normal binocular correspondence.

B. Diplopia: Vertical dissociation of as much as 20Δ in some cases, with or without red-green glasses, was used to elicit diplopia. If the direction and amount of diplopia did not agree with the angle as determined on the cover test, measured at the same fixation distance, a lack of normal correspondence was said to exist.

C. Red-green glasses: The patient views a muscle light at six to ten feet and the type and amount of diplopia elicited are noted. Any discrepancy between the prism neutralized angle, objectively determined, and the subjective separation (beyond a 5Δ error of measurement) was held to indicate some A.R.C. under the test conditions. If the results were questionable, the angle of squint was neutralized with loose prism, and the subjective impression of the patient was again noted. More than the 5Δ error of measurement equivalent separation of the red and green lights was considered as A.R.C.

D. The Hering or Bielschowsky after-image test[43]. At six feet, the subject, wearing distance correction, is exposed monocularly to a brilliantly illuminated filament one foot in length, placed horizontally for one eye, and vertically for the other. The patient is instructed to fixate a central target on the filament in both instances. The patient then reports the configuration of the after-images of the streak filaments, with the eyes open and then closed respectively. In both instances, for normal correspondence to be said to exist, the subjective impression should be a perfect cross.

E. Brock String test: This test is for binocular correspondence at the near point. A string four feet long is fastened at one end, and is held along the midline firmly at the bridge of the nose. A fixation light is held at or within the centration point or range respectively. The test was performed without red-green glasses unless deep suppression was evidenced at the near point. Answers indicating absence of correspondence were: a single string down the midline, appearing a mixture of red and green, with the fixation light split into red and green halves; or the "inverted Y" where the string between the nose and the fixation light is seen single (A.R.C.) but splits behind the fixation light (N.R.C.), thus forming the "Y."

12. Best corrected visual acuity at distance. The acuity was measured monocularly with a projecto-chart at twenty feet. The score was recorded as (—) if more than one letter on the lowest line attempted was missed.

13. Number of training visits attended, excluding original refraction and final evaluation session.

14. Rate of visit: Either once or twice weekly.

15. Attendance: Rated in three categories. Good, for an average of eight visits per month if twice weekly, or eight visits in two months if one visit per week was called for. Fair, for a six or seven visit average. Poor, for less than a six visit average.

16. Motivation of the parent: A subjective rating by the author in each case, in four divisions: Good, Fair, Poor, and Never Came (—).

17. Motivation of the patient: A rating by the author, based on the attitude of the patient toward the training, and the opinion of the staff clinician. Graded in three categories, Good, Fair, and Poor.

18. Does assigned home training. A rating from 1 to 5 (from poor to good) based on the child's account of the homework done between visits, and the staff optometrist's impression. No home assignments were given to three patients.

19. Therapy: Already previously covered under instrumentation. Under each classification of therapy, the recording was made as follows: Blank if not used at all. X if done moderately. XX if the main type of therapy given.

20. Resultant deviation: Tabulated as a percentage of the time that a turning is noticed by the parent, child, and the staff optometrist. Divided into three categories: 1% or less (functional cure), 5% (almost cured), more than 5% (failure).

21. Clear binocular vision: Either yes or no based on the acuity measurement, in addition to the patient's estimate.

22. Comfortable binocular vision: Based on the patient's estimate. X = yes. Blank = no.

23. Near point of convergence: Taken with a flashlight or ophthalmoscope light as a fixation target. Listed in inches as the examiner's estimate from the corneal plane. Normal considered as 4".

24. Stereopsis: Recorded as X meaning presence of and blank indicating absence. Considered in two categories: (A) Macular: Tested for on one or all of: Telebinocular DB6 Visual Skills Card or Keystone Airplane Series. Rotoscope stereo targets 14 to 20. Omnitrainer, AN Series transparencies. (B) Peripheral: Basic Stereo Motivator with intermediate screen, and rabbit and rings anaglyph series. Brock Wall Rings.

25. Range of motor fusion: The range in prism diopters using a peri-macular flat fusion target with sufficient detail to act as a check on accommodative effort: e.g. pumpkin, F and L, G O D, ball and arrows on the Rotoscope. On the Troposcope the cowboy, clown and dog, and tiger targets were used. Normal range was considered 8BI to 20BO or greater.

26. Tabulation of the results according to Flom's five categories previously defined: 1. Functional cure. 2. Almost cured. 3. Moderate improvement. 4. Slight improvement. 5. No improvement.

ANALYSIS OF THE SAMPLE BEFORE TRAINING

Total cases	149
Sex	68 male, 81 female
Wearing spectacles after initial refraction	111
Extent to which spectacles were worn:	
1. Constantly, single vision	61
2. Constantly, bifocals	20
3. Distance only	19
4. Near only	11
Direction of deviation:	
1. 54 eso	
2. 58 exo	
3. 17 hyper-eso	
4. 20 hyper-exo	
Variety of squint fixation:	
1. Unilateral	69
2. Alternating	80
Size of the deviation:	
1. Range:	
Smallest	9Δ eso = 4Δ hyper
Largest	60Δ eso
Hyper range	2Δ to 22Δ
2. Distribution:	
0 to 15Δ	55
16 to 30Δ	79
31 to 60Δ	15
Frequency of squint:	
1. Constant	80

2. Intermittent	50
3. Periodic	19
Absence of binocular correspondence:	
1. On at least one test	39
2. On three or more tests	26
3. On the after-image test	26
Age at the start of training:	
Distribution:	
1. 5 to 10 years	82
2. 11 to 15 years	50
3. 16 to 30 years	11
4. 31 to 44 years	6
Angle of squint altered by correction:	
A. Decreased by correction:	
1. Exo	18
2. Eso	54
B. Increased by spectacles:	
1. Exo	12
2. Eso	7
C. No change	20
Amblyopia:	
A. Acuity gradient, Brock[44] (Ratio of the acuity of the better eye/acuity of the poorer eye) Ratio greater than 2 in 16 cases	
B. Range in acuity of amblyopic eyes at the beginning of training: 20/40– to 20/300	
C. Corrected V.A. poorer than 20/40 in one or both eyes in 29 cases.	

ANALYSIS OF RESULTS OF TRAINING FROM AUTHOR'S TABULATION

I. *Overall Results of Training According to Flom Criteria*

	Funct. Cure	Almost Cure	Mod. Imp.	Slight Imp.	No Imp.
Patients	49	60	22	10	8
Per Cent	33%	40%	14%	7%	6%

Overall Results vs. Number of Cases and Per Cent of Cases

The patients shown in the "functional cure" group always had straight eyes, many showing no movement on either the alternating or monocular cover tests, at final dismissal from the regular clinic sessions. The others showed a small movement which was followed by instantaneous recovery. Performance of a complete refraction on each before dismissal revealed no indication of the previous manifest binocular deviation.

In the "almost cured" category, the patients' eyes were straight all the time under ordinary conditions, but tended to deviate when the patient was unusually fatigued, ill with fever, or under strong emotional stress; not more than 5 per cent of the time, and always with diplopia.

Combining the "functional" and "almost" cured groups, and adding four patients whose eyes are straight (Cases Nos. 25, 26, 47, and 146), but are listed as "moderately improved" because of the technical requirements of the "cured" categories (2 subnormal ranges

of motor fusion, 1 with a 7" N.P.C. rather than the required 4", and 1 with frequent asthenopia, headaches, and accommodative spasm), we may state that a total of 113 (76%) of the patients in the sample had binocular vision with straight eyes 95% of the time or more at dismissal from the regular clinic training sessions. The other 36 patients had residual deviations occurring more often than 5% of the time, and were classified as orthoptic failures. Of these, 8 of the "moderate improvement" group dropped out when quite near the "almost cured" category, i.e., with their eyes straight well over half the time, and possessing all of the technical factors necessary for a cure with several months of additional stabilization work.

This result was obtained under the following relatively poor clinical conditions: 1. Group therapy was conducted, with the patient receiving a limited amount of individual care. 2. Patients were seen by different clinicians with different personalities and philosophies of training. 3. Control and management of each case was relatively poor. The absence of these unfavorable factors in other types of training situations should yield even better results on a similar sample of strabismic patients.

II. *Patients Finishing Training Without Need for Spectacles*

Funct. Cure	Almost Cure	Mod. Imp.	Slight Imp.	No Imp.
13	14	4	4	4

No Need For Rx vs. Training Results

It is interesting to note that 27 (24%) of those in the "cured" columns, having straight eyes 95% of the time or better, did not require spectacles either to improve vision or to help adjust the accommodative-convergence neuromuscular mechanism to a normal condition.

III. *Number of Training Visits Made*

VISITS:

	Funct. Cure	Almost Cure	Mod. Imp.	Slight Imp.	No Imp.
Exo:					
Average	23	23	28	16	12
Range	11-57	10-76	11-66	9-24	12
Eso:					
Average	32	32	30	45	24
Range	15-70	11-68	11-59	9-71	10-33

Visits Made vs. Training Results for Exos and Esos

The exotropes required fewer average visits for each category of results and the range can be noted to have a substantial spread for each category and for both exos and esos.

IV. *Size of the Angle of Deviation of the Squint*

0-15Δ:	Funct. Cure	Almost Cure	Mod. Imp.	Slight Imp.	No Imp.
Exo	15	13	5	0	0
Eso	5	13	4	0	0

16-30Δ:					
Exo	18	16	4	2	1
Eso	10	16	5	4	3
31-60Δ:					
Exo	1	1	2	0	0
Eso	0	1	2	4	4

Size of Deviation vs. Results

The size of the angle shows a very high inverse relationship with the quality of results obtained. It is one of the most important factors in prognosis, only 3 of 15 cases (20%), where the angle was greater than 30Δ were in the "cured" categories. The consensus of the orthoptic literature is that the angle of deviation is very important in effecting a cure. Giles[5] states: "The number of visits required was proportional to the angle of squint." To see if Giles' contention was borne out by our data, the following table of size of angle against the number of visits was made for the *successful* cases only.

	Size of the Squint Angle		
	0-15Δ	16-30Δ	31-60Δ
9-20 visits	22	26	0
21-40 visits	19	24	2
41-70 visits	2	14	1

Size of the Deviation vs. Visits for the "Cured" Cases.

The table shows that there is a trend in the successful cases toward more visits for the higher angles of deviation.

V. *Age at the Start of Training*

	Funct. Cure	Almost Cure	Mod. Imp.	Slight Imp.	No Imp.
5-10 years	26	31	10	6	8
11-15 years	20	20	7	3	0
16-30 years	4	3	3	1	0
31-44 years	0	6	0	0	0

Age at the Start vs. Results of Training

In the youngest group, the incorrect neuromuscular habits of strabismus were not of long standing, but motivation and attention span were poorest, so that at the pre-school and early school ages most of the "functional cures" were recorded, and also most of the failures. If the child's motivation and interest could be stimulated, the results were generally good. Of the adults who were motivated to undertake training, straight eyes were the result in all nine patients over twenty-one years of age. Absolute "functional cures" by Flom's definition were not obtained in these adults, since either: stereopsis could not be elicited, or residual deviation with diplopia, occurred up to 5 per cent of the time, but all could be classed as "almost cured."

VI. *Age of Onset of the Strabismus*

Age of Onset*	Funct. Cure	Almost Cure	Mod. Imp.	Slight Imp.	No Imp.
0-1 yr.	4	7	6	5	0
1-2	8	7	4	1	4
2-3	2	9	2	2	0
3-4	5	6	1	0	1
4-5	9	7	2	0	1

(VI. Continued from preceding page)

5-6	6	3	0	1	0
6-7	2	2	1	0	0
7-8	2	0	2	0	0
8 over	7	7	0	0	0

*Unknown in 23 cases

Age of Onset vs. Results of Training

The age of onset is claimed by almost every writer on strabismus to be the most important determinant in achieving a cure. According to the results in the present study, a relationship is apparent. All of the onsets after eight years of age are to be found in the "cured" categories. Onset before one year of age did not preclude a "cure," providing the angle was small and training was commenced at an early age. Eleven cures (50%) and eleven failures were obtained for onsets below one year of age. Of those cases with onset under three years of age, 37 of 61 (61%) were "cured," and for those patients with onset later than three years, 56 of 65 (86%) are to be found in the two "cured" classifications. In twenty-three instances the patient or parent could not state when the eye first turned. The danger of drawing conclusions from information which is not verifiable in most cases, is only too apparent.

VII. *Sex Differences in Training Results*

	Funct. Cure	Almost Cure	Mod. Imp.	Slight Imp.	No Imp.
Male	19	27	11	7	5
Female	30	35	10	3	3

Sex of Patient vs. Results of Training

A small sex difference was found in favor of the girls, most probably due to the intractability and shorter attention span of the younger boys, coupled with the greater motivation of the girls to remove the cosmetic stigma of an ocular deviation.

VIII. *Patients Dropping Out Before Completion*

	Funct. Cure	Almost Cure	Mod. Imp.	Slight Imp.	No Imp.
Cases	0	20	9	4	1

Training Results vs. Dropouts

Those patients attending eight or more sessions, but dropping out before final dismissal were mostly in the "almost cure" and "moderate improvement" groups. These patients dropped out after two to four months of work, when the good results of the training were becoming apparent; the deviating eye being straight almost all of the time, and the patient having voluntary control over the deviation. The usual reasons for dropping out was inconvenience, long travel time (up to two hours each way in some cases), and school schedule changes.

IX. *Direction of Deviation*

	Funct. Cure	Almost Cure	Mod. Imp.	Slight Imp.	No Imp.
Eso	10	21	11	6	6
Exo	27	22	7	2	0
Hyper-eso	4	10	0	2	1
Hyper-exo	8	7	4	0	1

Results vs. Direction of Deviation

A higher percentage of exotropes (82%) finished in the "cured" categories, and fewer failures were sustained, than for the eso group, (64%) "cure," both with and without a vertical component. The weight of evidence in the literature is non-committal on whether better results are obtained in training convergent or divergent deviations, there being almost an even division of opinion in the twenty-odd references expressing an opinion, reviewed by the author.

X. *Regularity or Frequency of Turn*

	Funct. Cure	Almost Cure	Mod. Imp.	Slight Imp.	No Imp.
Constant:					
Exo	6	8	3	2	1
Eso	7	26	12	8	7
Intermit.:					
Exo	20	15	6	—	—
Eso	5	3	1	—	—
Periodic:					
Exo	10	7	—	—	—
Eso	1	1	—	—	—

Training Results vs. Regularity of Turn

As might be expected, more intermittent (96%), and periodic (100%), squints resulted in straight eyes, than in the constant strabismics (59%). The exotropias again show a higher rate of "cure" than for the esos in all three groups.

XI. *Variety of Squint Fixation*

	Funct. Cure	Almost Cure	Mod. Imp.	Slight Imp.	No Imp.
Unilateral Exo	12	14	3	0	0
Unilateral Eso	7	17	6	4	5
Alternating Exo	21	15	6	2	1
Alternating Eso	9	14	7	4	2

Variety of Squint Fixation vs. Training Results

The consensus in the literature reviewed is that unilateral squints are easier to train and with better results than the alternating squints. In our study, there is not a significant difference (only 1%) between the totals in the "cured" categories for the alternators 74% (59 of 80), and 73% (50 of 69) for the unilateral. The exotropes again show a higher rate of "functional cures" and "almost cures" for both the alternating and unilateral strabismics.

XII. *Anomalous Correspondence*

A lack of binocular correspondence manifested on three or more

tests was the factor most closely related with failure; 85% (22 of 26) of these did not finish training in a "cured" category. The detection of lack of binocular correspondence in an eso case is much more ominous than in an exo. Only 23% of the esotropes with an anomalous response on even one test (6 of 26) were "cured" while 62% (8 of 13) exos responding anomalously to one or more tests ended training within a "cured" category. All 8 of those in the "no improvement" column, and 9 of 10 in the "slight improvement" column gave A.R.C. responses on two or more tests.

	Funct. Cure	Almost Cure	Mod. Imp.	Slight Imp.	No Imp.
Lack of Correspondence:					
One Test	5	3	1	0	0
Two Tests	2	1	0	1	0
Three Tests	0	1	2	3	2
Four Tests	1	2	3	5	5
Five Tests	0	0	1	0	1

Training Results vs. Anomalous Correspondence

The After-Image Test alone indicated the future failure in 77% (20 of 26) of those responding to it anomalously.

	Funct. Cure	Almost Cure	Mod. Imp.	Slight Imp.	No Imp.
Cases	3	3	5	8	7

Anomalous After-Image Response vs. Training Results

XIII. *Attendance, Motivation and Homework*

	Funct. Cure		Almost Cure		Mod. Imp.		Slight Imp.		No Imp.	
Attendance:	c	d	c	d	c	d	c	d	c	d
Good	35	0	19	9	5	2	5	2	2	0
Fair	14	0	19	8	6	5	1	2	6	0
Poor	0	0	3	3	1	2	1	0	0	0

where c means completing training
and d means dropouts

Training Results vs. Attendance

Motivation of Parent:	Funct. Cure	Almost Cure	Mod. Imp.	Slight Imp.	No Imp.
Good	45	38	14	8	4
Fair	3	6	3	0	0
Poor	0	1	1	1	0
Adults and older children, no parent came	4	15	3	1	4

Training Results vs. Parent Motivation

Motivation of the Child:	Funct. Cure	Almost Cure	Mod. Imp.	Slight Imp.	No Imp.
Good	38	22	11	1	0
Fair	11	36	7	6	7
Poor	0	2	3	4	1

Motivation of the Child vs. Results

Does Home Exercises*:	Funct. Cure	Almost Cure	Mod. Imp.	Slight Imp.	No Imp.
1 (poor)	0	0	0	2	2
2	1	4	4	2	1
3	5	30	5	2	2

4		39	19	9	3	2
5	(good)	5	6	3	1	0

*Exercises not given in 3 cases

Results vs. Diligence in Home Assignments

As is true in any learning situation; e.g., school, musical instrument, sports, etc., the regularity of attendance, motivation and diligence in practice or homework are important factors in determining the final results. In the case of orthoptic exercises, apparently, on the basis of the tables from this study, attendance, motivation, and proper effort in performing assigned home work are sufficient but not necessary factors in obtaining good results. Thus, those patients with poor attendance, poor motivation, etc., never resulted in a "functional cure," although good attendance, etc., did not necessarily result in a "cure," the other factors (I to XIII) previously mentioned weighing heavily in the final result. See Figure I.

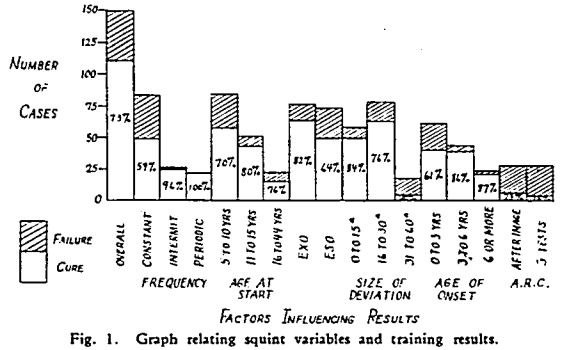

Fig. 1. Graph relating squint variables and training results.

CONCLUSIONS

1. The results of the study indicate that orthoptics including occlusion and in conjunction with refraction, yields results on a large number of unselected strabismics, in which the eyes are straight cosmetically, and binocularly functional 95% of the time or better in 76% of our sample (73% according to the Flom criteria), at dismissal from regular clinic training. These results were obtained under clinical conditions which were not optimal; (group therapy, poor control, different practitioners, etc.) and better results should be obtained where these unfavorable factors do not enter.

2. Orthoptic results are better in a highly motivated patient,

(and parent), who attends training sessions regularly, with a squint: of angle less than thirty prism diopters, of late onset (after three years), of short duration, which occurs intermittently or periodically, is divergent (exo) in direction, and where binocular correspondence is present.

3. The prospects of failure are greatest where a squint of large angle, is constant, of early onset, is lacking binocular correspondence, and the motivation of the parent and patient is less than optimal: which in turn leads to poor attendance and a sluggish effort in clinic and on assigned home exercises.

4. Those results in this study which correlate strongly with the consensus of the literature are: size of the angle of deviation (four to one odds against curing a case with an angle larger than 30Δ), the effect of anomalous correspondence (four to one odds against cure of a case with A.R.C. on three or more tests), and the regularity of turn (59% rate of cure for constant turn, and 98% average rate for intermittent and periodic turns). Our results which disagree strongly with the orthoptic literature are: Alternating vs. monocular (74% to 73% "cures" respectively) whereas the literature strongly favors better results for the unilaterals; age of onset (50% "cures" for onset under one year, and 61% "cure" for those onsets under three years, whereas the literature finds the cure of early onsets almost impossible; and, age at the start of training (76% "cures" over the age of 16 years), the majority of other writers feeling that results are good only at the very early ages. The factor with the greatest lack of agreement within the literature, (opinion being about evenly divided), is the expected results with respect to direction of deviation of the squint. Our results show 82% "cure" for exotropes vs. 64% for the esotropes.

5. The Flom criteria provide a handy vehicle for defining the final results in a strabismus case, and the five categories of results nicely evaluated the final outcome for the most part. Only the disposition of the four patients with "moderate improvement," whose eyes were straight and binocular 95% of the time or better, but who failed one or more of the technical requirements for either of the "cured" categories is questionable.

6. A surprising 24% of the patients in the "cured" categories did not require the use of spectacles upon dismissal.

FUTURE RESEARCH

1. It was shown in the present study that orthoptics as a therapeutic measure in strabismus, can help three out of four concomitant, previously untreated, unselected (as to prognosis) strabismic patients. It has not shown the long term effects of this training on the binocular

neuro-muscular mechanism. A study is therefore called for, to re-analyze the 113 patients dismissed with straight eyes (95% of the time or better) in three years, to see if the binocular rehabilitation is a lasting one. Such a study is planned by the author.

2. A detailed and comprehensive analysis of the factors responsible for the orthoptic failure in 36 of the 149 strabismics is called for. This study is already underway.

3. Because it may be claimed by those such as Law[34] and Douglas,[41] that the strabismus would have cured itself anyway in many of the "cured" strabismics in this study, and that the orthoptic effort contributed little to the final results, a large scale controlled study is called for. Two groups of strabismus cases, non-pareric and non-operated, with an equal distribution of age of onset, sex, age, size of angle of squint, presence of binocular correspondence, and direction of deviation, in the two groups should be assembled. The control group should have only refractive care on a regular yearly basis for five years. The experimental group is to have complete refractive and orthoptic care for the same period of time. The results are then to be tabulated and statistically analyzed for the actual contribution of the orthoptic training on the strabismus.

4. Because of the very poor results obtained on esotropic patients with anomalous correspondence in this study, and as reported throughout the world, further research should be organized to help understand and work out better treatment routines for this very difficult binocular problem.

5. Since samples of strabismics vary in composition, this present study should be repeated by other workers, with a larger unselected sample of strabismus cases if possible, to validate the present study.

6. Because excellent results can be obtained with pre-schoolers who can be motivated: more attention must be devoted to motivating techniques, specialized instrumentation, and methods of increasing rapport and attention span in these very young squinters.

7. Because other methods of general squint therapy are utilized, a study comparing the rate of functional cure obtained by refraction alone, by surgery alone, and by orthoptics alone, would certainly seem to be in order. The author is planning such a study.

SUMMARY

1. A twenty-five year review of the orthoptic literature was made and fifteen pertinent reports on the efficacy of orthoptics as a strabismus remedy were cited and discussed. Five general objections were raised to these papers.

2. Flom's criteria and classification of results of strabismus therapy were quoted and utilized in the present study.

3. The orthoptic procedures at the Optometric Center were discussed, and the instrumentation listed for six classifications of therapy.

4. Criteria for inclusion in the study were enumerated, with 149 patients meeting the criteria.

5. The 149 cases were tabulated under twenty-six items, which categorized and classified the strabismus. The twenty-six categories were listed and briefly discussed.

6. The sample of 149 cases was analyzed before training, according to twelve pertinent factors.

7. The results were portrayed in tables and one graph: discussed, compared, and analyzed.

8. Conclusions were drawn from the study, on the efficacy of orthoptics as a remedial measure in strabismus, at dismissal from regular clinic training sessions. On a sample such as ours, the odds are three to one in favor of an expected cure.

9. Suggestions for further research called for by the results of the present study were listed and discussed.

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ANNOUNCEMENT

SPECIAL FRAME FOR CATAREX LOAN SERVICE .

In order to service requests from laboratories, dispensers and professional men for a sturdy round-eye frame with cable temples to be used with Catarex temporary lenses. The Vision-Ease Corporation plans to offer a 1/10th 12-karat gold-filled frame meeting these specifications, according to Robert E. Conn, Jr., Vision-Ease Sales VP.

The new product, called "Catarex Temporary Frame," features a strong bridge, precision-beveled eyewires, adjustable rocking pads and comfort cable temples. It has no ornamentation other than a modest reverse bevel on outside surfaces to break the otherwise plain appearance of the gold-filled. Eye sizes range from 40 mm. through 46 mm., bridges from 20 mm. through 24 mm. Available cable temples range from 5¼" through 7" (L.O.) in quarter-inch graduations. The new Catarex frame will be available for delivery from Vision-Ease stocks on August 1, said Mr. Conn.