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VOL. 44. NO. 2

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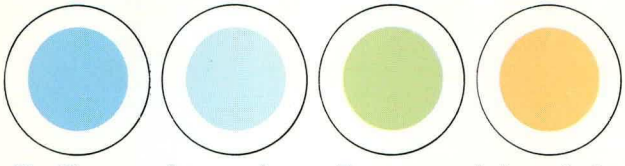

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THE CANADIAN JOURNAL OF OPTOMETRY

LA REVUE CANADIENNE D'OPTOMETRIE

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In this Issue — Low Vision/Vision Training

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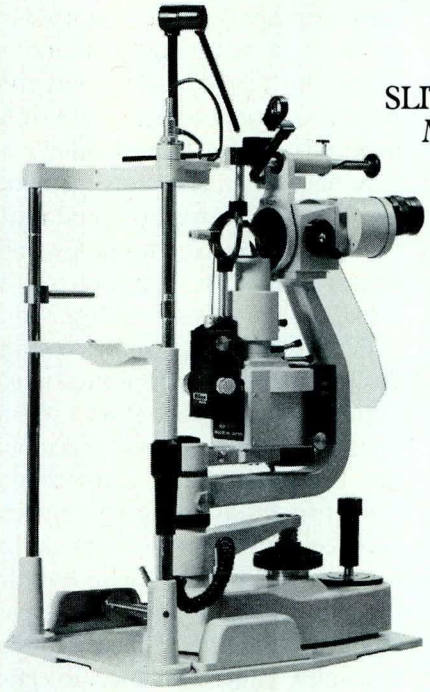

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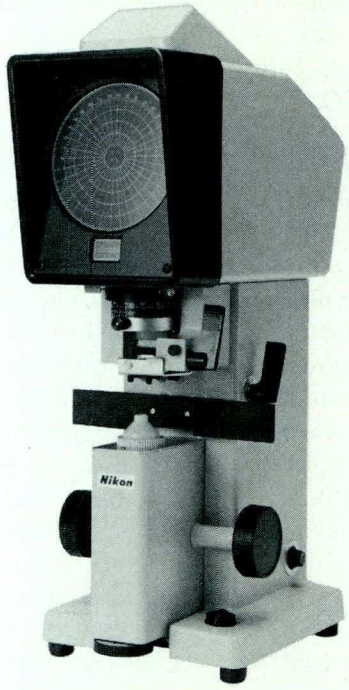

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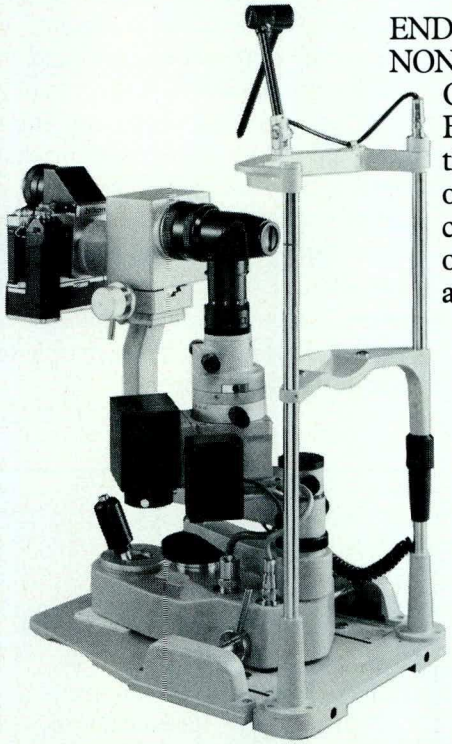

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EDITORIAL

Fact and Fantasy in Advertising

Among the many functions of a professional journal is the conveying of product information from manufacturers who use the journal for advertising to their prospective clients, namely the practitioners of that discipline. The tenor of such ads should be appropriate for the nature of the product and the professional reader.

In recent months there have appeared in many optometric journals a number of advertisements, particularly those concerned with auto-refractors, which lack good taste and seem to be talking down to optometrists, the possible purchasers of these instruments. These advertisements appear to have overlooked the fact that optometrists are educated, sophisticated professionals well able to make discriminating judgements on the clinical value of these electronic devices.

The format and approach seem more like the efforts of Madison Avenue executives addressing unsophisticated lay people rather than scientific consultants and engineers discussing highly technical instruments with knowledgeable and responsible professionals.

There appears to be a discrepancy between the stated objective of better vision care and the claims of reduced examination time, greater time to spend with a patient and increased patient load. What are the implications of such statements?

A practitioner will consider the purchase of an auto-refractor once his practice has reached a certain level and he expects the instrument will help relieve the pressure. Suppose an 8 hour day of which seven hours are allotted to clinical work and, to be fully employed, one patient per 30 minutes, or 14 patients per day. Any increase in patient load means less time spent with each patient. Fifteen patients means 28 minutes per patient; 20 patients means 22 minutes per patient.

What then would be a reasonable increase in patient load made possible by the acquisition of an auto-refractor? Can the use of such an auto-refractor so enhance the efficiency and productivity of a fully booked practitioner that a 20%, a 40%, a 50% or even a 75% increase is possible and still allow the maintenance of adequate professional quality vision care? For example, 40 patients a day means only 11 minutes per patient for a 7 hour day fully devoted to clinical practice.

Can this type of reduced patient time be described as "better care"? What kind of visual analysis can be given in eleven minutes? Moreover, by no stretch of the imagination can the practitioner spend more time with each patient.

Refractors are but sophisticated retinoscopes. The only time saved, if the procedure is performed by para-optometric personnel, will be the 3 or 4 minutes required to carry out a retinoscopy. Surely it is apparent that the double claim that auto-refractors save time and permit practitioners to spend more time with each patient, or to see more patients, are mutually exclusive. If the practitioner utilises this "saved time" counselling the patient or performing other tests, he does not save *any* time so he cannot see more patients. But he will create an environment conducive to better care. If he accumulates this "saved time", he may be able to see more patients. He does not, however, spend more time with each patient but less, nor does he create an atmosphere for better care in a rush-rush situation.

Professional optometric standards demand that a thorough visual examination and analysis include investigation of eye health and mobility, refractive state, accommodation, binocular integrity, muscle balance and other sensory-motor functions. Can one explain how, by substituting a refractor for a retinoscope, the above routine can be significantly reduced in time? To claim otherwise is demeaning of optometric care for *the implication is that a "quickie subjective exam" is the usual optometric standard of quality vision care!*

Advertisers, in preparing their texts, should be more cognizant that optometrists are professionally educated people, fully capable of discriminating fact from fantasy in advertising. Ads in professional journals should be on the same intellectual plane as that of the people to whom they are directed.

G.M.B.

OPINION

Multifocals and Progressives Alternative not Superiority

In the past two or three years there have appeared a number of studies indicating popularity of certain types of progressive power lenses over other types[1] and of progressives over standard segment type bifocals.[2,3,4]

To date, no study comparing progessives to trifocals has come to this writer's attention. Until such a study is done, the question of popularity of progressives will remain unsolved despite some results favouring progressives over bifocals. Why have the manufacturers of progressive power lenses failed to compare their product with trifocals? Are they fearful that the outcome would not be as favourable as with bifocal lenses?

This writer, based on his knowledge of geometric optics and lens types, of personal use of bifocals and trifocals and of progressive lenses (both Ultravue and Varilux II), plus thirty-seven years of clinical practice, believes that progressives, apart from their cosmetic appeal, are overplayed because of the inherent restrictions in their design. We are not implying that standard multifocals have no restrictions, but simply that claims made on behalf of progressives mislead some practitioners and the public who conclude that these "no-line lenses" can meet any optical need of the public.

Have readers ever attempted to compensate for induced vertical prism due to an anisometropia, to adjust base curves to avoid possible aniseikonic effects, to provide base in prism in the reading area for convergence problems or even to provide a wider and undistorted field of vision in the working or reading area? Perhaps the genius of Bernard Maitenaz, the designer of the generating machine which permitted the production of progressive power lenses,[5] will, in the future, give us progressive lenses incorporating all the parameters required in practice. But on the other hand, what would happen to present lens types if "Gradient index optics" became a practical, clinical reality[6]?

The primary objective of any prescription for an ophthalmic appliance is to meet the visual needs of the patient. Practitioners should not "give in" to the cosmetic demands of the patient if a progressive power lens cannot meet his visual needs. At least, in the writer's practice, most requests for progressives stem from novelty and cosmesis. — newness does not necessarily mean superiority.

The most successful first generation progressive lens used in the writer's office was the "Zoom" which is no longer available.[5] Nonetheless, the writer has never been enthusiastic about progressives due mainly to the distortions and aberrations found in the periphery or adjacent to the true optical zones of these lenses. In fact, if a standard single vision or multifocal lens had such faults, it would be *promptly rejected*. The same might be said about the visual results with soft contact lenses. Why do we take so much pain to determine an accurate refraction only to ignore part of our findings when fitting the soft lenses?

Perhaps some personal experiences with Ultravue or the Varilux II could be of interest. Admittedly, the writer's correction does influence his impressions of the usefulness of these two types of lenses:

$-3.25 - 3.50 \times 180$ ¾ Δ Base up
$-3.00 - 3.25 \times 165$ ¾ Δ Base down
add plus 2.00
C.V. Trifocal set 1mm below lower edge of pupil.

Because of the position of the segment, the beginning of the progressive area does not create a problem. A diplopic image caused by looking through the segment line is no more annoying than the blur and distortion created by the progressive power to either side of the progressive channel. In fact, it may be more annoying with progressive lenses because a segment line does not extend to the edge of the lens except for the executive.

At near, the Varilux gives only 2 newspaper columns of clear definition and these are trapezoid, narrower at the top and more angled to the left. A 15 degree head turn produces an uncomfortable lateral distortion and blur to the side opposite the head turn. These lateral aberrations and the narrow field can be tolerated when reading a book but become intolerable with a newspaper.

The Ultravue gives a slightly wider field but the edges have more blur. The trapezoid effect does not exist.

In the intermediate ranges, 18 to 36 inches, vision is good in the straight ahead direction but the lateral field is only 8 to 10 inches wide compared to the 24 inches available with the trifocals intermediate segment. This reduction in the field width is the most objectionable feature of the prescriptions. It is in the examination room that they have been most annoying. After several trials, both Varilux and Ultravue have been abandoned for in-office use.

If personal experience is any cirteria for judgement, the most-used area of the trifocal in a home or office environment is the intermediate segment and we suspect that the same would be said for most patients. The narrowness of the progressive channel becomes a major feature in counselling a patient on

the use of progressive lenses. As Borish has indicated[1] the head turner will accept a progressive more easily than an eye turner. And in this respect progessives would be a boon to aphakics if such high powered lenses could be cosmetically produced. Have designers ever given thought to meeting the aphakic's spectacle needs with a progressive power lens?

Clinicians may or may not have noticed that a progressive lens demands more head movement up and down than a segment because the reading power is at the bottom of the progressive area, at least for the Varilux. The shorter channel of the ultravue is about similar to the trifocal. In a bifocal the N.V.L. is some 8-10 mm below the distance optical center, 15-17 mm in a trifocal and 18 or more in the Varilux. The N.V.L. can be raised by giving more than the required add but this may disturb the intermediate ranges, the raison d'être of a progressive lens.

On the street, both Varilux and Ultravue provide clear distance vision edge to edge, but once into the progressive area to either side of the channel, vision is blurred and distorted; the Varilux causes vertical lines to slope 15-20 degrees to the left and 10 degrees to the right; the Ultravue causes undulations of the floor but vertical lines are upright.

In all this discussion the center of controversy is clear undistorted vision at near and at far. These two faults are not the same. Depending on head position things may be upright but blurred; in other positions the print is clear but sloped. As the ads say, "a smooth progression of power in every direction"; a correct statement, no doubt, because the lens surfaces vary smoothly and so does power, but is this the lens power the patient requires to correct his ametropia?

Oh yes, except in the office, the writer uses these prescriptions on occasion but what a relief to get back to a lens free of aberrations and distortions!

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G.M.B.

CAO TRAFFIC LIGHT VISIBILITY SURVEY

This brief survey first appeared in the December, 1981 issue of the CJO. Response from C.A.O. members has so far been, to say the least, disappointing. In a recent follow-up interview on the project's progress, Dr. Mintz stated that a similar survey was being sent to selected samples of motor vehicle jurisdictions, as well as traffic engineers all across Canada. Those results are to be integrated with the results from our own membership. Accordingly, we ask you to please read this page and, using the *postage prepaid card*, forward your replies to Dr. Mintz. We thank you for your assistance and co-operation.

As the representative of the CAO on the Roads and Transportation Association of Canada, I have undertaken a study of the visibility of arrows used in traffic lights. These traffic light arrows are available in many patterns but the most common ones indicate one direction per signal unit. These arrows may be displayed with red or amber lights or may be displayed alone. One signal light may consist of a solid red, solid amber, and solid green lights along with one or more of the following: an arrow pointing to the right; an arrow pointing to the left; an arrow pointing up (indicating straight ahead movement).

The initial phase of my study is to determine whether or not a problem exists among drivers in determining the direction indicated by the arrow(s). With this in mind, I am soliciting your assistance by answering a couple of questions below. You may, if you wish, provide further assistance by spending a four-week period keeping more precise statistics of those who present themselves with a complaint of difficulty with the traffic lights (Please do not ask patients if they have problems with the arrows; wait for them to mention the problem).

Your co-operation is much appreciated.

1. *Within an average month, approximately how many patients have volunteered information that they have difficulty determining the direction indicated by traffic light arrows:*
   - *a. no patients*
   - *b. 1- 5 patients*
   - *c. 6-10 patients*
   - *d. 11-15 patients*
   - *e. 16-20 patients*
   - *f. 21 or more patients*
   - *g. unable to answer (i.e. no arrows in community, or unaware of a problem with arrows)*
2. *Of those patients noted in 1. (above), approximately what percentage would you say present themselves to you with acuity of $^{20}/_{40}$ or better (i.e. acuity measured as the patient is normally driving* before *any correction you may prescribe).*
3. *City, municipality, or location of your main office (i.e. where the majority of your patients are seen).*
4. *(Optional) Name and Address.*

Please forward all replies, within 60 days, to:

Dr. Steven Mintz
212A Regent Ave. W.
WINNIPEG, Manitoba
R2C 9Z9

St. Vital Vision Screening Study

Elwood J. Spearman*
Arthur J. Rathgeber**

Abstract

This paper discusses briefly, in general terms, the principles and objectives of school screening programmes, some of the screening techniques available and the choice and training of lay operators. In particular, it outlines the objectives for a province-wide screening project proposed by the Manitoba Vision Conservation Committee, a multi-disciplinary group.

Abrégé

Ce travail débute avec une brêve discussion générale des principes et buts des programmes de dépistage, de quelques techniques de dépistage disponibles et du choix des opérateurs. Plus specifiquement le travail expose les objectifs d'un programme visuel provincial proposé par un comité multi-disciplinaire, le Manitoba Vision Conservation Committee.

Introduction

School is where children attend to sensory stimuli and integrate these experiences through cognition. A successful demonstration of this very complex process is learning. Any system that is not intact in this process contributes to the child's failure to demonstrate learning. Wilson and Wold[1] point out that 80-90% of what is learned is mediated by vision. An intact and efficient visual system, therefore, is of key importance. The incidence of vision problems has been estimated to be between 20-30% (Sloane and Rosenthal)[2]. At the very beginning of our learning chain is the visual sensory system. An ideal method for insuring that every child's visual system is intact would, according to Sloane[3] ". . . be to have every child subjected to a very complete eye examination as early in life as possible . . : " (p.13). It would be difficult to achieve this ideal, so a second alternative is to provide a screening program. Reber[4] suggests that the purposes of a school's screening program are "to detect those children who have visual problems that affect the physiological or perceptive processes of vision and to find those children who have visual problems that interfere with performance in school." (p.675). Reber aims at a complete screening program encompassing physiological and perceptive processes. Determining perceptual difficulties that contribute to learning problems is a critical issue in the educational setting and needs to be addressed with interdisciplinary research and clinical efforts. However, without attempting to detract from the above statement by Reber, this discussion will only address physiological vision screening.

An important study in the literature which was reported by Reber was the Danbury study, done by Leverett in 1955. Several new concepts were introduced in this study:

1) The screening program was discussed with optometrists and ophthalmologists before the study.
2) Children already under care were treated differently than those without spectacles.
3) All failures were retested.

In the Danbury study, the Massachussetts Vision Test was used. It was found that there was a small over-referral rate.

Reber also discussed another important study in the vision screening literature: The Orinda study[5], which was read before the annual meeting of the American Academy of Optometry in Boston on December 13, 1958. This study was a joint venture of the School of Optometry at the University of California and the School of Medicine at Stanford University. The two best screening techniques reported by this study were, in order of effectiveness:

1) Modified Clinical Technique
2) Massachussetts Vision Test

The Modified Clinical is a comprehensive battery of tests that needs to be administered by a professional eye care practitioner. Because this technique requires professional involvement, the cost for this program would likely be prohibitive for most school divisions. The second screening program, the Massachussetts Vision Test, is based on the use of three tests: a) visual acuity b) plus lens c) muscle balance.

The Members of the Provincial Vision Conservation Committee of Manitoba developed a number of screening techniques and modified instrument criteria with the use of lay screening personnel, similar to the Massachussetts test, and also meeting the criteria as established in the Orinda study.

Implementation of the vision screening program in Manitoba had five goals (Rathgeber and Spearman)[6].

1) To develop a screening process to identify children who may have a) reduced acuity b) hyperopia or c) a phoria which may interfere with academic performance.

* Developmental Optometrist, Fellow, American Academy of Optometry, Member-Committee for Children With Learning Disabilities, Canadian Association of Optometrists.

** Doctoral Student in the School of Special Education and Rehabilitation at the University of Northern Colorado. Previously Special Education Consultant with the Manitoba Department of Education and Chairman of the Provincial Vision Conservation Committee of Manitoba.

2) To set up an effective system that would encourage eye-care practitioners in local communities: a) to support the screening process, b) to be available for consultation to schools, c) to provide clinical feedback to the Provincial Vision Conservation Committee.
3) To involve school personnel in the screening process to increase their knowledge base with respect to vision and its implication for learning.
4) To develop a program that would allow school divisions to manage and maintain an effective vision screening program.
5) To expand the scope of the Provincial Vision Conservation program beyond the identification of vision problems and teacher education to three additional areas: a) parent education, b) pupil instruction, c) visual environment.

In addition to having comprehensive goals to guide the committee, as suggested by Gregg[7], the cooperative effort by optometry and ophthalmology in Manitoba is similar to a unique feature of the Danbury study of 1957 (reported in Reber). The actual vision screening techniques are reported in Rathgeber and Spearman.

The purpose of this paper is to report a study supported by the Manitoba Provincial Vision Conservation Committee in the spring of 1979.

Method/Procedure

Subjects were students in the St. Vital School Division–an urban school division within the metro Winnipeg area. The population was selected from schools which represented the various socio-economic levels in the community. 732 children from kindergarten, Grades 1, 3, 5, and 7 were screened for myopia, hyperopia and phorias. The children were screened by resource teachers employed by the school division. Screeners received one day of instruction and practical experience prior to the start of the program. They were instructed in the use of the Random Dot E*., Goodlite Insta-line**, and Bioptor*.

In addition, the Program was carefully administered and monitored by the Chairman of the Manitoba Vision Conservation Committee, Mr. A. Rathgeber, in consultation with the three optometrists and two ophthalmologists who were instrumental in the development of the program.

All three instruments were used in kindergarten and Grade 1. In Grade 3, 5, and 7 the Random Dot E was eliminated.

The trained screeners screened 732 children on the first screening. 216 (30%) of the children failed the first screen. The children failing the first screen were screened a second time. Second screening is the administration of those tests failed in the first screen. In the second screen, more time was taken to administer those tests failed the first time. 113 (15%) failed the second screen.

TABLE 1:
Screening Results
(kindergarten, Grade 1, 3, 5 and 7)

No. screened	732
No. who failed first screen	216 (30%)
No. who failed second screen	113 (15%)

Children failing on the second screen were examined by either an optometrist or ophthalmologist who was affiliated with the study. One half of the children were examined by the optometrist in his office and the other half were examined by the ophthalmologist at the Manitoba Health Science Center Eye Clinic. Adapted criteria from the Orinda study were used for the professional examination and are noted in Rathgeber and Spearman.

Results

1st Grade

Of the 216 children screened in kindergarten and the 1st Grade, 74 (34%) failed the first screen. On the second screen, 26 of the 74 children failed. Therefore, 12% of the total number of 216 failed the second screen. These children were professionally examined. 10 of the 26 children (38%) demonstrated no problem, but 16 (62%) of the 26 were in need of professional care. These children needed immediate care in the form of glasses or vision training, or a potential vision problem was noted.

The student was considered to have a potential vision problem when he/she failed one of the screening tests. For instance, the student might fail the plus lens test and the professional examination might show + 1.50 of hyperopia. Yet no symptoms and no problem in classroom achievement will appear. The child might show a visual acuity of 20/30 (slight myopia) but have no difficulty in everyday function. The phoria might be just outside the parameters of the established criteria but again the child shows no symptoms or difficulty with classroom achievement. These children were considered "at risk" in that they did not require immediate professional attention but should be seen for review in six or twelve months.

3rd Grade

In the 3rd Grade, 178 children were screened. On the first screen 38 (21%) of the 178 children failed. After the second screen, 19 (11%) of the total of 178 failed. These 19 children were professionally examined. 6 (32%) children demonstrated no difficulties, but 13 (68%) of the children required a prescription immediately or a potential vision problem was noted.

5th Grade

In the 5th Grade, 185 children were screened. On completion of the first screen, 57 (31%) of the children failed. After the second

* The Random Dot E and the Bioptor are available from Bernell Corporation, 422 East Monroe St., South Bend, Ind. 46601.
** The Goodlite Insta-line is available from Goodlite Company, 7426 Madison St., Forrest Park, Ill. 601130.

screen, 45 (24%) of the 185 children failed. Following a professional examination, 15 (33%) of the 45 children demonstrated no problem and 30 (67%) of the 45 required professional care. These children required a prescription or a potential vision problem was noted.

7th Grade

In the 7th Grade, 161 children were screened. On the completion of the first screen, 55 (34%) of the children failed. After the second screen, 31 (19%) of the 161 children failed. Following a professional examination 7 (23%) of the 31 children demonstrated no problem, whereas 24 (77%) of the 31 required a prescription or a potential vision problem was noted.

Under – Referral

A small percentage of randomly selected children at the kindergarten and Grade 1 Level (15%) and at the Grades 3-5-7 levels (7%) were professionally examined after passing the screening tests. This was done in order to estimate the under-referral rate, which is the number of children who would not be referred for a professional examination based on the screening instruments and would require professional attention. In every screening program an under-referral rate is expected due to instrument deficiencies and the fact that lay people do the screening. The under-referral rate for this program was approximately 3%. This is well within the range reported by similar programs. However, a strong committment to teacher in-service impacted on this program's respectable under-referral rate.

Discussion and Considerations

In most cases after the professional examination, more than 2/3 of the children required some care. Either this was an immediate prescription or some potential vision problem was noted by the eye-care practitioner. In addition to being an effective program to identify children with vision difficulties, this program also appears to miss a minimum of children requiring vision care. This is reflected in the low under-referral rate.

TABLE 2:
Screening Results by Grade Level

	Fail 1st Screen		Fail 2nd Screen		Professional Examination Results Of Those Failing The Second Screen			
					Care Needed		No Problem	
Kindergarten & 1st Grade	No.	Per-cent	No.	Per-cent	No.	%	No.	%
No. = 216	74	34%	26	12%	16	62%	10	38%
Grade 3 No. = 178	38	21%	19	11%	13	68%	6	32%
Grade 5 No. = 185	57	31%	45	24%	30	67%	15	33%
Grade 7 No. = 161	55	34%	31	19%	24	77%	7	23%

Several factors are noted from our experience in Manitoba;

1) The committment of both optometry and ophthalmology to work together to develop an effective screening program for the children of Manitoba was of critical importance.
2) The adaptation of the Massachussetts Vision Test to reflect local practitioners' standards of care proved to be an essential component.
3) Criteria recommendations from the Orinda study were very valuable in the development of the Manitoba Screening Program.
4) The future success of such a program will depend upon the control of two major variables.
   a) *instrument criteria* – assessed by feedback from practitioners and subsequent modification of criteria, if necessary.
   b) *Lay screener reliability* is very much dependent upon thorough training sessions and monitoring of techniques.
5) Annual in-services for teachers and screening personnel are necessary, as new teachers and screeners may be utilized each year.
6) The support of all vision and eye care practitioners is important. All practitioners should be well-informed of the details of the program in order to avoid unrealistic negative criticisms to parents or pupils.
7) The referral letter to the parents should indicate which screening tests were passed or failed by the student so that the practitioner may pay particular attention to the reason for referral.
8) The program has created a greater awareness among teachers and parents of the importance of vision and eye care and the relationship of vision to learning.

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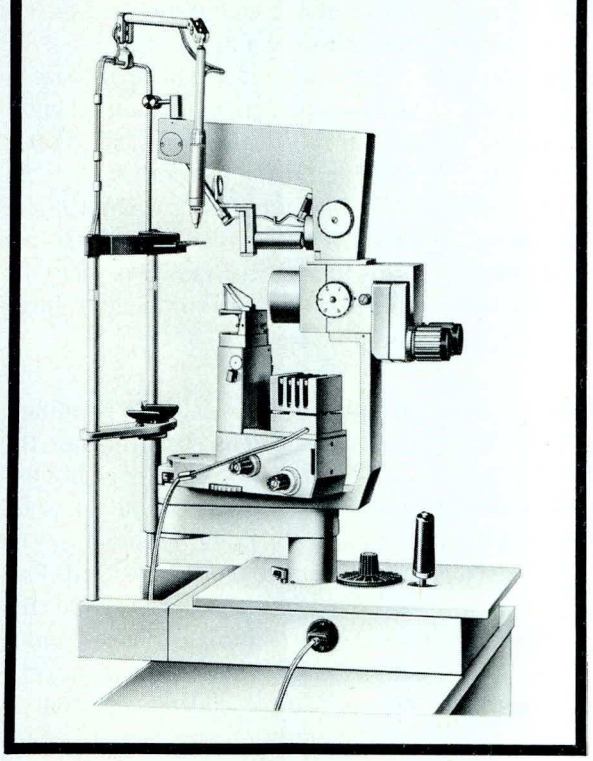

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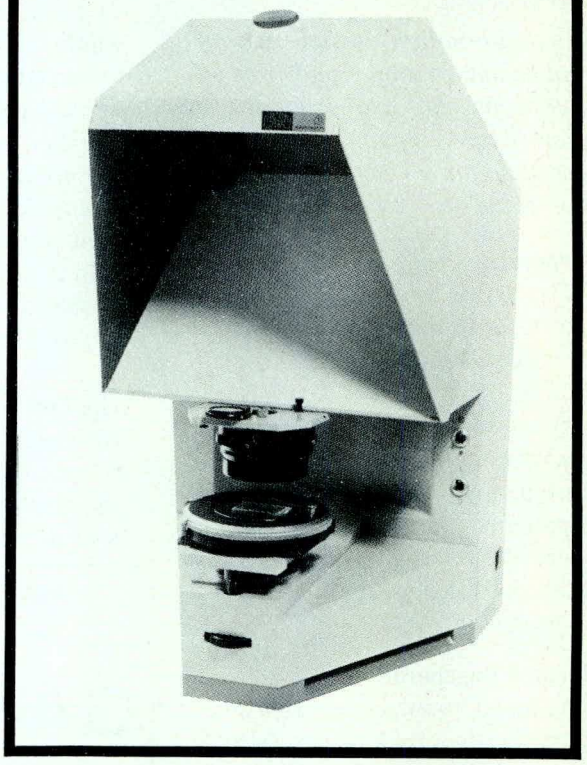

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Helping Low Vision Patients to Read Again

Don Salmon*

Abstract

Rehabilitation of the low vision patient is both optical and psychological. This paper purposely neglects the optical consideration in order to stress the human management aspect of rehabilitation.

Abrégé

La rehabillitation du patient souffrant de basse vision est à la fois optique et psychologique. Ce travail ignore l'aspect optique pour mettre l'emphase sur le coté humain et psychologique de la rehabillitation.

Purpose:

This article is intended to help the private optometric practitioner in his office. It is also directed specifically to helping low vision patients who suffer from *senile macular degeneration*. In our low vision clinic these people form the vast majority of patients and their most frequent desire is to read again. We have seen about 500 such patients in the last 2½ years.

Macular Degeneration:

As we all know *senile macular degeneration* has its basis in vascular lesions which cause the dysfunction of cones in the macular area of the retina. One of the results is the presence of *central scotomas*. In low vision patients these scotomas are usually present in both eyes. However they are normally more severe in one eye than the other, and are also located somewhat differently on each retina.

The consequences of these factors are that the patient does not have normal binocular vision. In fact the patient tends to use his "one best eye". However to use the residual vision in his "best" eye most effectively, the patient cannot look straight ahead. Instead he must turn his eye in such a way as to make use of an eccentric area of his retina. This kind of monocular eye movement control can be extremely difficult. Remember that in all his previous life it was a neurophysiologically ingrained function to look straight ahead, and the whole neurological design was built to encourage just that. The difficulty of *finding* the best eccentric position and then *maintaining* it is greatest in the act of reading where such fine motor control is required for any kind of enjoyment. This article is to help the private optometrist do this by sharing our trial and error clinical experience.

The Low Vision Examination:

We shall not go into the optics of helping these low vision patients to any great extent. What we try to do is to determine some form of high plus spectacle, single vision or bifocal; or microscopic spectacle; or handheld magnifier; or combination of spectacle and handheld magnifier, that at a given working distance (always much closer than normal) will permit the patient to identify *single digits* of about 1M (20/50 on JS) size on a suitable near point card such as the one shown in figure 1.

If the identification of 1M size is not possible, then we want to know what is the smallest print size that *is* possible for the patient.

We have found that whatever size this is, it is a good guide to the size of print the patient may *ultimately* be able to read, after sufficient training and practice.

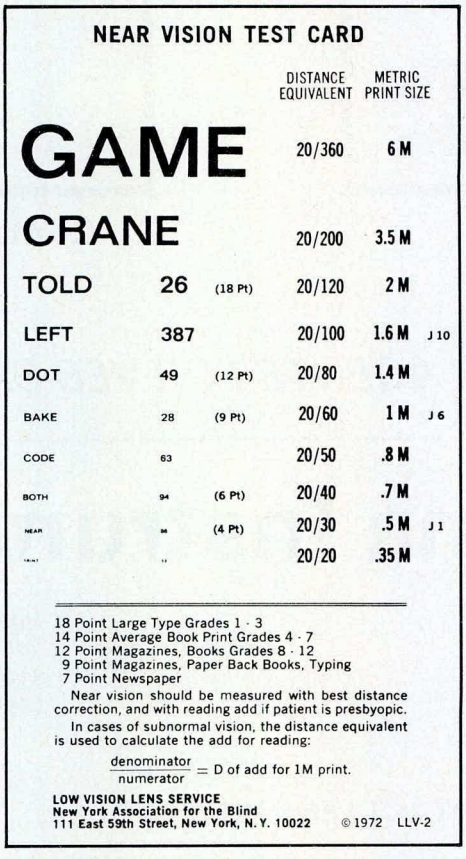

Fig. 1. Low Vision Near Point Test Card

Training & Experience in Reading:

For the private practitioner the key point is not to expect his low vision patient to be able to read, right away, print of the same size he could identify on the test card. Psychologically this is very hard for the average practitioner, because most of the time we work with normal people and our spectacle or contact lens prescription give immediate results, immediate feedback, both to you the practitioner and to the patient. With macular degeneration patients it is different. You must not allow yourself to become discouraged when your patient cannot read immediately. More importantly you must not allow your *patients* to become discouraged because reading may seem so hard at the time of the examination.

Your patient has a whole set of new skills to learn, chiefly aimed at the control of that eccentric retinal area which is all he has left now.

By and large the patient has not learned these skills prior to your examination. First of all he usually doesn't understand his condition and what he must do to read. You can help a great deal by explaining it

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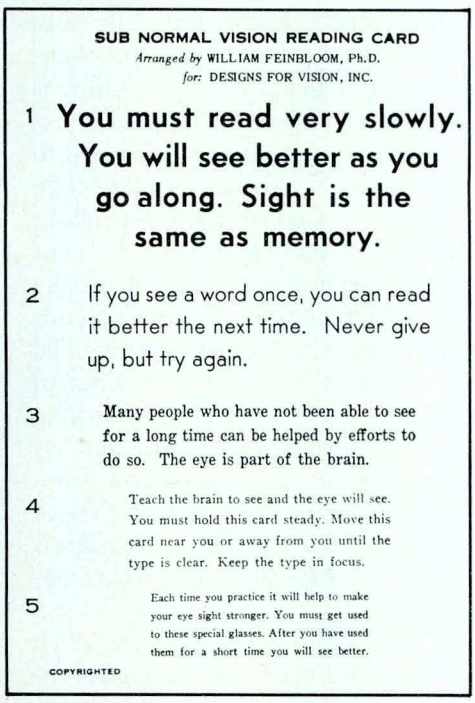
carefully to him. Secondly, until now, he has not had a corrective lens adequate enough to provide even the eccentric retinal area with an image magnified sufficiently for him to "get hold of", visually speaking. Now, following your low vision exam, he has, and he can begin learning.

Begin Training With Large Print Materials:

Think of the training job you have, as practitioner, as one of providing retinal information of sufficient size to enable your patient to learn to find and keep the best eccentric retinal position.

As an optometrist an appropriate magnification lens has been provided and the correct working distance determined by you for your patient.

Now you must provide home training exercises. The key to this is to begin with *large print* material and *short* words and phrases. These will provide the strongest retinal feedback to the patient. We ask our patients to practice at home for fifteen minutes a day with materials such as those shown in figures 2 and 3. They are told to begin always with large print, and to read *out loud* so as to involve kinesthetic, muscular aspects in learning. They are told not to worry if they can't read smaller print right away. The whole rationale is thoroughly explained to them.



SUB NORMAL VISION READING CARD

Arranged by WILLIAM FEINBLOOM, Ph.D.

for: DESIGNS FOR VISION, INC.

1 **You must read very slowly. You will see better as you go along. Sight is the same as memory.**

2 If you see a word once, you can read it better the next time. Never give up, but try again.

3 Many people who have not been able to see for a long time can be helped by efforts to do so. The eye is part of the brain.

4 Teach the brain to see and the eye will see. You must hold this card steady. Move this card near you or away from you until the type is clear. Keep the type in focus.

5 Each time you practice it will help to make your eye sight stronger. You must get used to these special glasses. After you have used them for a short time you will see better.

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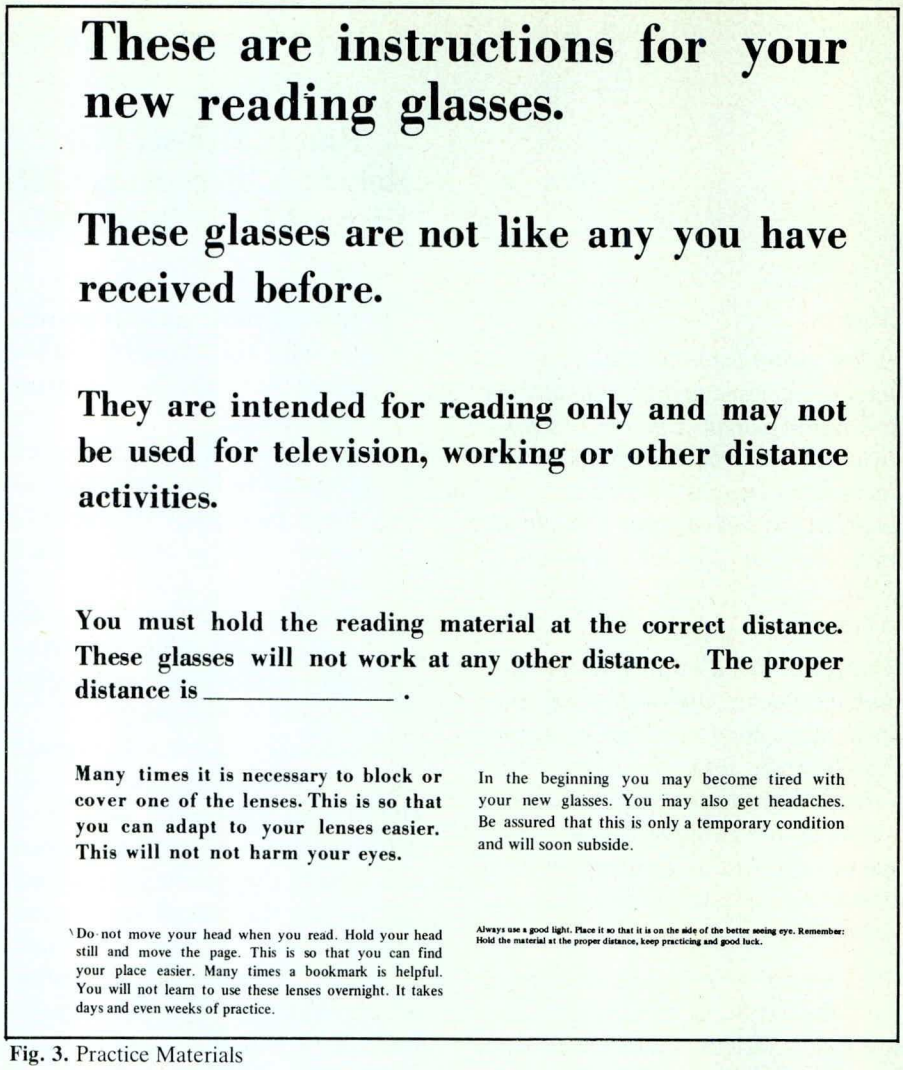
Fig. 2. Practice Materials



These are instructions for your new reading glasses.

These glasses are not like any you have received before.

They are intended for reading only and may not be used for television, working or other distance activities.

You must hold the reading material at the correct distance. These glasses will not work at any other distance. The proper distance is _____ .

Many times it is necessary to block or cover one of the lenses. This is so that you can adapt to your lenses easier. This will not not harm your eyes.

In the beginning you may become tired with your new glasses. You may also get headaches. Be assured that this is only a temporary condition and will soon subside.

Do not move your head when you read. Hold your head still and move the page. This is so that you can find your place easier. Many times a bookmark is helpful. You will not learn to use these lenses overnight. It takes days and even weeks of practice.

Always use a good light. Place it so that it is on the side of the better seeing eye. Remember: Hold the material at the proper distance, keep practicing and good luck.

Fig. 3. Practice Materials

In fact the reading of even large print is very encouraging to the patient and spurs him on, because up to now even that has not been possible. Now it is a real accomplishment.

We usually ask our patients to return in a month's time to show us "what they can do." During this time they are asked to call a Low Vision Assistant for further guidance, if necessary.

Of Clipboards and Lamps:

At close working distances and where the depth of focus of high convex lens systems is limited, reading is much easier if the material is flat. So by all means encourage your patients to put their material on a simple clipboard and hold it close.

Lighting is critical for best retinal functioning, even more so with low vision patients, even with the best lens system. We usually urge the use of a table model or floor "goose neck" type lamp that can be placed beside and slightly behind the patient's head, about a foot or so from the material. A 60 or 100 watt bulb is usually sufficient and is not too hot at that distance from the patient's body.

Conclusion:

We have not compiled statistical results in this area at our clinic. But we hope sharing our clinical experience will help you and your low vision patients. One of ours with 20/300 vision now reads a regular book a month.

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Low Vision in Primary Care Optometry*

Randy T. Jose, O.D.
Robert A. Browning, O.D.
Richard L. Brilliant, O.D.

Abstract

A low vision examination procedure has been devised to differentiate those low vision patients who can be helped by the primary care practitioner from those who require referral to a specialized low vision clinic for help via optical aids and/or rehabilitation.

Abrégé

Une procedure d'examen en basse vision a été developpé pour déterminer quels patients de basse vision peuvent bénéficier de soins du practicien de premier ligne de ceux qui doivent être référés à une clinique specialisée en basse vision pour l'obtention d'un aide en basse vision et la rehabillitation.

Every optometrist has been faced with the problem of managing the low vision patient in the busy private practice setting. It is difficult to gain enough experience to know when to refer and when to provide services because of the low incidence of low vision patients in the private practice. If the practitioner decides to refer, then he risks sending the patient for unnecessary extended trips and creating financial burdens for the patient. Many times the patient cannot be helped by the "low vision centers" and/or the patient could have been helped with simple bifocal adds, etc. without having to have made the trip.

This is a constant dilemma for a primary care optometrist, so the authors developed a minimum low vision diagnostic sequence which will allow the practitioner to more confidently refer patients for this specialized care. The purpose of the sequence is to:

1. Identify those patients who can be helped or whose care can be initiated in the *local* primary care setting.
2. Identify those patients that will respond to low vision aids but have problems beyond the scope of the primary care setting.
3. Identify those people who are not candidates for low vision aids, so that unnecessary referrals will not be made.

The doctor will be able to make these determinations based on good clinical data if the sequence is used. This initial exposure to low vision aids allows the primary care clinician to give the patient specific reasons for the referral and essentially becomes a "diagnosis." This primary care clinician maintains management of the patient through this type of knowledgeable referral. The sequence also benefits the low vision clinician since the patient arrives with some realistic knowledge of low vision aids. The minimum low vision diagnostic sequence will help the primary care clinician enjoy the rewards of managing low vision patients within the scope of his/her practice and avoid the frustrations of trying to work with patients needing a multi-disciplinary service center.

It is important to define primary and secondary care. A primary care setting is designed to handle a large number of people in a short period of time. All routine problems and even some specialized problems can be handled in this time frame. If problems exist beyond this time frame (psychological and/or physiological) then this one patient starts interfering with the primary care clinician's responsibilities to his/her other patients. It is at this point that secondary care services are needed. Under this definition the referral is made because the patient needs time committments (and maybe special equipment/lenses) that are not within the scope of a well-managed primary care setting and *not* because the primary care clinician is incapable or incompetent. . . .

Primary Care Low Vision is obtaining enough data in a short period of time to make a reasonably accurate prognosis for solving the individual's reported problems with low vision aids. Generalizing, the presbyope is an excellent example of a primary care low vision patient. As the near point acuity gets lower, the lenses needed are stronger and the patient's use of the lenses is more stressful. Some people adapt to the limitations of these stronger lenses and others need to be trained to comfortably use them. The need for patient training and redesigning of lens systems is the point at which the patient becomes a candidate for secondary care services. All optometrists practice low vision daily with geriatric patients. As the problems become more severe, more time is needed to resolve them. The secondary care service is organized to provide this extra time (average eight hours per low vision patient), has the additional professional staff to handle these patients, and usually maintains a larger inventory of aids to resolve unique problems. The "specialist" is simply the clinician who has a special interest in working with these unique problems and has the support facilities to accommodate all the needs of these low vision patients. The secondary care clinic is a resource for the primary care optometrist.

The examination sequence which follows will assist the interested optometrist in identifying which pa-

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tients can adapt to aids easily and which will need the extended time offered by the interdisciplinary center.

The Minimum Low Vision Diagnostic Series is presented in an annotated outline form so it can be referred to when that occasional low vision patient arrives in the office (usually unexpected and on the busiest day!).

1. Case History

The case history should include the following basic information:

A. Has the patient successfully used optical aids before? (If so, there is a better prognosis for success with aids since the patient is familiar with them.)
B. Does the *patient* know the cause of the impairment? (If the patient says, "I'm blind," there may be problems with motivation. The patient is dwelling on the loss of vision.)
C. Does the patient travel around by himself/herself? (Mobility is an indication that the patient is using his/her residual vision.)
D. How does light affect vision? (Sometimes a visor or sunglasses can solve most of the patient's problems.)
E. What kinds of social activities does the patient engage in? (Again, this gives the examiner an idea of how much the patient is using residual vision.)
F. Does the patient have special vocational/educational problems attributed to the vision loss?
G. What special problems does the patient want the doctor to solve? (Be careful of the "I want to see you again" syndrome. This person will need lots of attention.)

Generally speaking, the case history should give you a good clinical impression of:

1. How independent this person is and how much the residual vision is being used.
2. Specific problems that will most motivate the patient when you are deciding on a prescription.

II. Distant Visual Acuity

This is the first and most important diagnostic test. It can be the first time a patient has actually read a chart. Use a Feinbloom Number Chart (see Figure 1) or at least a regular wall chart. Use the following procedure:

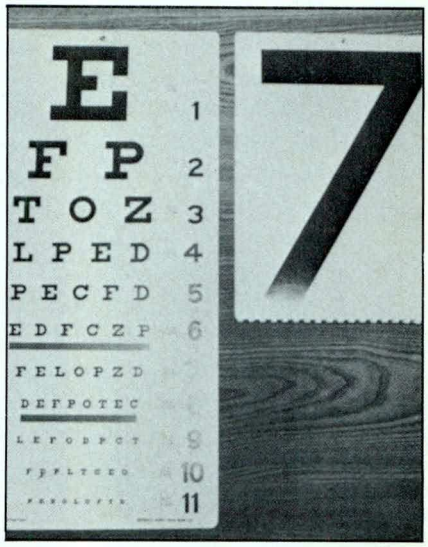


Figure 1. The Designs for Vision Number Chart has a range of acuity optotypes from 2/700 to 20/20. At two feet a 20/7000 equivalent acuity can be obtained. Likewise, the AO Chart at two feet gives you an equivalent acuity of 2/200 or 20/2000.

A. Present the Feinbloom 700 foot number (2/700 or 20/7000) or the Snellen 200 foot letter (2/200 or 20/2000 at two feet).
B. Back off to ten feet (five is acceptable if the patient reports the letter or number is getting blurred at this distance).
C. Let the patient read the numbers or letters on the chart slowly. Encourage the patient to guess and isolate the *optotypes* to get greater success. The more letters or numbers the patient is able to read, the more confidence the patient will have in the examiner. That is why it is important to work at five feet instead of ten feet if in doubt.
D. Repeat for the other eye. Usually start with the *reported* better eye first. Always get a measurement of each eye even when the patient says there is no vision in the other eye.
E. Since the Feinbloom Chart allows acuities of 20/7000 (700 foot letter at two feet) to be recorded, there is no reason to use the antiquated term "finger count." (If a patient can count fingers, he can see a 20/200 E.)
F. Some patients need to eccentrically view in order to obtain the best acuity. Encourage the patient to "look around the blind spot" and observe the position of the eyes when the best acuity is obtained.

III. Refractive Error Determination

Before investigating any optical aids, be sure that any acuity loss noted is due to the pathology involved and not due to previously uncorrected refractive errors.

A. Use a trial frame for objective and subjective testing.
B. Perform radical retinoscopy at 20 cm or closer if necessary to obtain a reflex. At least get a starting point for the refraction.
C. Do Keratometry to discover possible astigmatic refractive errors. Keratometry can be done on individuals with nystagmus. Do not cover the non-tested eye as this may increase the nystagmus.
D. If a retinoscopic reflex cannot be obtained, begin the subjective utilizing $\pm 2D$; $\pm 5D$; $\pm 10D$ and $\pm 20D$ lens choices to elicit some response. Work with $-2D$ and $-5D$ cyls at the four major meridians as a subjective test for astigmatism.
E. Record the new refraction with the new acuities. Demonstrate this to the patient in the trial frame and then compare it to the old Rx. Often the patient will report no difference even though the re-

corded acuities indicate seemingly significant improvements.

F. Repeat for the other eye. Never consider an eye hopeless without trying. The subjective should be a relaxed procedure. Do not hurry decisions and use large lens changes as needed for the patient to see a difference.

IV. Telescopic Evaluation

The clinician will need only two telescopes to ascertain the patient's prognosis for successful use of telescopic devices: A 2.5x monocular telescope and a 6x/8x combination monocular telescope. In Figure 2, the Selsi 2.5x and 6x/8x are shown. The 6x has the shorter objective and the 8x has the larger objective. Use the following guide to determine the appropriate telescope to use:

1. 20/100, best corrected distant acuity or better	2.5x
2. 20/100 to 20/300 best corrected distant acuity	6.0x
3. 20/300 to 20/600 best corrected distant acuity	8.0x
4. If the best corrected distant acuity is less than 20/600	Poor prognosis for use of telescopes without extended training.

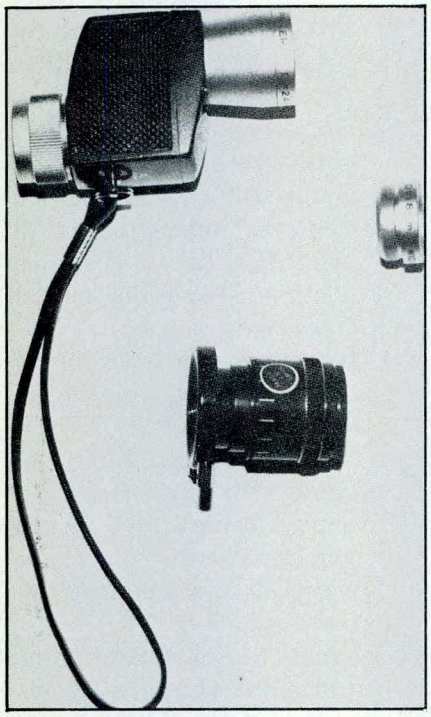


Figure 2. The 6x-8x Selsi Telescope has two objectives. The telescope is shown with the 8x objective mounted. This can be removed and the shorter 6x objective used instead. The 2.5x Selsi is used for those individuals with better acuity.

After determining which telescope to initially evaluate, the following procedures should be done (nystagmus is not a contraindication to the use of telescopes):

A. The doctor should focus the telescope initially for a ten foot viewing distance.

B. Have the patient locate a large object at the end of the room first. Having the patient find the doctor's white coat while he/she stands next to the chart is often helpful to the patient in getting oriented and locating the acuity chart.

C. If the patient cannot find the chart within a few minutes, discontinue the test. Do it in a positive manner by indicating that you "have another test to get that information. . . ."

D. If you are using the 6x telescope, the successful patient will be the one who quickly finds the chart and reads at an acuity level six times better than the habitual acuity (i.e., from 20/300 to 20/50).

V. Nearpoint Acuities

The chart easiest to use for this is the Lighthouse Near Acuity Test Chart (Figure 3). This chart is already calibrated to assist in determining a *starting point* for the near correction.

A. Hold the Chart at 40 cm.

B. Determine the optimum lighting level for the patient.

C. Have the patient read only one column of letters: (right column—right eye, etc.)

D. Look for eccentric viewing and/or encourage patient to eccentrically view.

E. Record monocular acuities—again record for both eyes.

F. For those who cannot read any letters at 40 cm, move the chart to 20 cm and obtain an acuity. If the patient reads 4M it is recorded as .2/4M instead of the 40 cm notation .4/4M. (These people will usually be candidates for referral.)

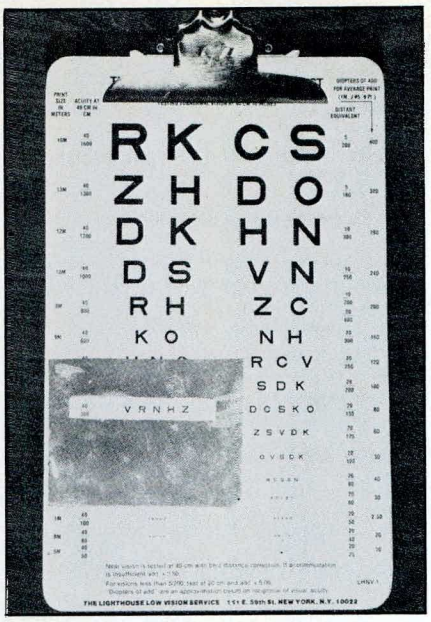


Figure 3. The Lighthouse Near Acuity Test Chart is an excellent card for taking near acuities. The optotypes are well spaced, high contrast and the right hand column indicates the dioptric lens needed for the patient to read 1M. A typoscope or reading slit enhances contrast.

VI. Microscopic Evaluation

Improving an indiviual's ability to read or at least identify words at near is the easiest task to work with in low vision. However, it must be approached with success or the patient will be easily frustrated.

A. After getting the best acuity for the better eye, note the dioptric value of that line on the right hand side of the Lighthouse Near Acuity Test Chart (Figure 3). This dioptric value indicates the approximate magnification the patient needs in order to "see" 1M* print, (i.e., can *see* newsprint) size letters but can usually only *read* larger typewritten materials). This number is doubled if the acuity was taken at 20 cm.

B. Adjust the lighting on the chart again to an optimum level.

C. Place the appropriate lens power from your trial lens set or AO microscopic set in a trial frame.

*The M notation of near acuities is described in detail in the text Low Vision Care by Edwin Mehr and Allan Freid. Professional Press.

D. Have the patient place the card on his nose and push it away until it comes into focus. Measure this distance. It should equal the focal length of the lens in the trial frame. If not, adjust the distance for the patient to see if the letters clear up subjectively. If not, record this variation in distance as it may indicate uncorrected refractive errors or other problems.

E. Have the patient read down the column of letters to 1M print. Always check lighting and focal distance as the patient reads down the chart.

F. The patient should be able to read 1M print with the indicated lens power. Note any discrepancies and try to figure out why 1M was not read. Was it refractive error problems, field losses, confusion, avoidance of working distance, etc.?

You may wish to use a typoscope (reading slit) for the nearpoint evaluation. It helps the patient keep his place when using the microscope and it sometimes leads to dramatic improvements in acuity due to the contrast enhancement it provides. Illumination and contrast are very important aspects of the nearpoint evaluation.

VII. Visual Fields

Visual Fields are performed on every patient with the main intent being to determine the extent of the intact retina available for magnification. Fields are usually performed before evaluating aids, but they can be done at any point during the sequence when a severe field loss is expected. For instance, if the patient shows excessive scanning when taking acuity measurements, this may be indicative of very restricted fields. The usual techniques are used with some exceptions:

A. Tangent Screen is a good routine test. Use large 6mm to 20mm targets. An X can be taped at the fixation point to help those individuals with central scotomas maintain steady fixation (Figure 4). The clinician should observe the patient throughout the test for fixation changes, eccentric viewing, etc.

B. Perimetry is performed on those patients who exhibit severe field defects with tangent screen testing. It gives more information pertaining to a patient's reported mobility problems. Again, large test targets and enlarged fixation targets will increase the reliability of the patient's responses.

C. Amsler grid describes how a patient is *eccentrically viewing*. The chart with the fixation cross is the best to use. Have the patient fixate "normally" and then plot the loction of the scotoma. If it's central, the patient may need eccentric viewing training. If the scotoma is to the right of fixation, the patient may have to be trained to eccentrically view superiorly. When the scotoma is to the right of fixation, it will interfere with reading with optical aids.

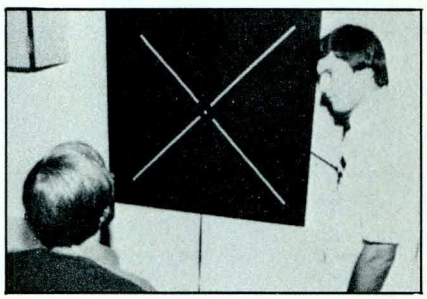


Figure 4. Masking tape can be used to make a cross on the tangent screen to help the patient with central scotomas fixate more steadily.

This is the basic set of diagnostic tests that comprise the minimum diagnostic low vision sequence. Of course a complete health evaluation is a mandatory part of any workup. Any medical problems will usually be attended to prior to initiating low vision services.

VIII. Patient Management

The data should be analyzed and one of the following decisions should be made:

A. Patient Cannot Be Helped—the acuity is so poor, expectations so high (looking for a miracle cure) and responses to aids were not impressive. The patient is advised that other rehabilitation services are available. Since the patient knows what low vision aids are—he/she can return for further evaluation if it is decided that one of the aids described and/or shown would be of potential benefit. The decision that a patient cannot be helped is now based on hard clinical data. The clinician still leaves the patient on a positive note and better educated as to rehabilitation potentials.

B. The Patient Can Be Best Managed in the Private Local Setting—the patient has realistic expectations, specific tasks in mind that are reasonable and the acuity levels and responses to aids indicate that the patient should be able to attain the established goals, with a minimum of training.

C. The Patient Needs a Multidisciplinary Evaluation—this patient has the acuity to use aids but not the motivation. There are complicating factors to the successful use of aids such as small central 5° fields, multiple central scotomas, 20/600 acuity or worse, resistance to working distances or inability to comfortably use aids due to fine-motor problems.

Figure 5 shows a graph that may help the clinician depict the patient pictorially in trying to make the management decision. If all the plotted points are to the left (i.e., very active patient with 20/60 acuity, full fields, needs +8 diopter add to read 1M and successfully used a 2.5x telescope) the patient should be initially managed in the office. If the patient is not very active, has 20/400 acuity, has 10° fields and did not respond well to the use of a 10x micro-

scope (lost his place, resisted work distance), couldn't use a telescope well and had no specific objectives other than wanting to see better; all the plotted points will be to the right and indicate the need for the secondary care approach of an interdisciplinary team. The graph should help in the analysis of the first few cases. As more patients are seen and services provided in the office, the clinician will gain more experience in making these management decisions and will gain the clinical confidence to try to work with a wider array of clinical problems presented by the low vision patients.

The equipment needed is minimal, and can be obtained from the companies indicated. A partial list of companies is included. These companies should be contacted for catalogues and the clinician should become familiar with the aids available through each.

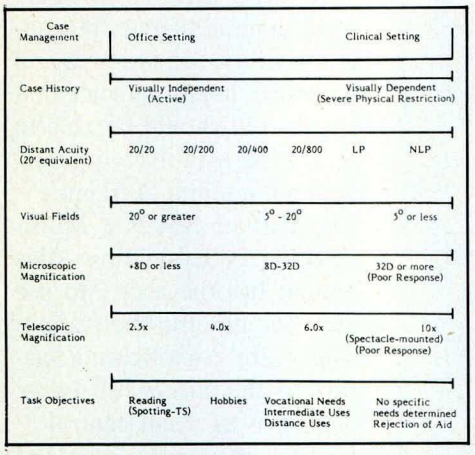


Figure 5. This represents a graphical presentation of data obtained from the Minimum Diagnostic Sequence. It may be useful to the clinician in making initial management decisions. All plots on the left are indicative of a patient who can be managed in the private practice.

Equipment: Low Vision Diagnostic Sequence

1. 2.5x Selsi Monocular—148A—Lighthouse
2. 6x—8x Selsi Monocular—162—Lighthouse
3. Near Acuity M Cards—LHNV—1—Lighthouse
4. AO Nearpoint Paragraph Cards—American Optical
5. Distant Test Booklet—Designs for Vision
6. Basic Microscopic Trial Kit—American Optical
7. E.F. Trial Lens Clips—Bernell Corporation
8. Trial Lenses/Trial Frame/Tangent Screen/Amsler Grid available in practitioner's office.

Resources:

American Optical Company
Low Vision Aids Service
Dept. 3401, P.O. Box 1
Southbridge, Massachussetts 01550
(617) 765-7711 ext. 3259

Optical Aids Service
Lighthouse for the Blind
111 East 59th Street
New York, New York 10022
(212) 355-2200

Designs for Vision
120 East 23rd Street
New York, New York 10010
(800) 221-7974

Bernell Corporation
422 East Monroe Street
South Bend, Indiana 46601
(219) 234-3200

Selsi Optical Company
40 Veterans Boulevard
Carlstadt, New Jersey 07072

Keeler Optical Products, Inc.
456 Parkway
Lawrence Bank Industrial District
Broomall, Pennsylvania 19008

Recreational Innovations Co. (NOIR)
P.O. Box 109
South Lyon, Michigan 48178

Sam Walters, Inc.
412 West 6th Street, Suite 625
Los Angeles, California 90014
(213) 622-0744

OIO Products, Ltd.
P.O. Box 613
Mauhasset, New York 11030
(516) 487-8576

Visual Tek
1830 Lincoln Boulevard
Santa Monica, California 90404

Summary

The minimum low vision diagnostic sequence consists of a battery of tests that can be easily incorporated into the routine of the private office. Perhaps with the exception of the total case history and the refraction, the diagnostic series can be administered by an optometric technician in the extremely busy office. In any case, it provides the practitioner with an easy mechanism to insure that all the low vision patients receive appropriate care either through direct services or referral. Referring a patient through this system can be as effective a practice builder as if the total service was provided in the office. The practitioner can evaluate the data collected and make one of three determinations:

1. No further help is possible.
2. I can handle this case in my office.
3. This patient should be referred for a comprehensive rehabilitation program. The practitioner has the data to tell the patient exactly why the referral is being made and has demonstrated the need for referral to the patient, thus maintaining excellent patient management.

This decision is based on information from the case history, visual acuities, magnification responses, and visual fields. The interrelationship between these data and the various factors involved can be weighed and a decision made based on clinical data.

The equipment needed to administer the minimum low vision diagnostic sequence is relatively inexpensive (approx. $350.00) and is listed in detail. The sequence is outlined for quick reference and should be utilized as a step by step guide for the first few patients. As the practitioner gains some skills and familiarity with this aspect of optometric care, individual modifications can be made to the sequence to suit the individual's mode of practice. Hopefully this approach will be useful to

Cont'd on P.81

New Optometric Institute of Toronto Looks to Future

In a recent news release, the Board of Directors of the Optometric Institute of Toronto announced that it has received its Letters Patent as a non-profit corporation.

The objectives of the newly-created Institute are as follows:

(a) To assist in the advancement of the standard of optometrical services in the community and to promote and conserve the vision of the public, and to foster inter-professional coordination in so doing;

(b) to provide facilities for continuing optometrical study and education for optometrists;

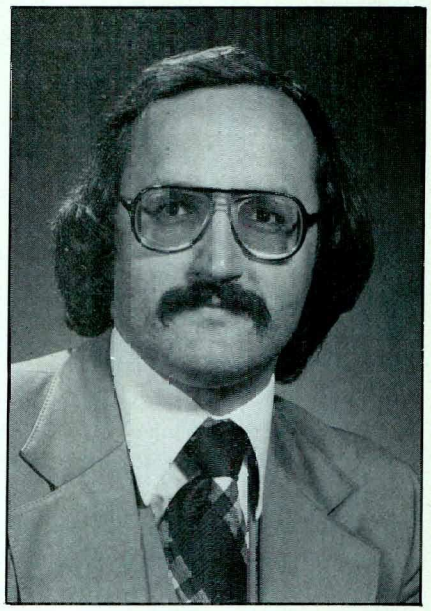
(c) to promote, encourage and to participate in the advancement of optometrical research and preventative optometry;

(d) to arrange for the provision of clinical facilities for the practice of optometry for the objects stated in (a), (b) and (c) above;

(e) to encourage participation of the public in the operation of the Institute;

(f) to disseminate information to the public for the purpose of promoting and conserving the vision of the public.

The Institute, as indicated by its objectives, will sponsor the provision of the full spectrum of optometric care. Clinical programs will involve general examinations, binocular vision, low vision, contact lenses and special diagnostic procedures. Initially, emphasis will be on primary care services with other areas developing more fully as referral sources increase. Out-reach programs for underserviced segments of the population will receive priority status. It is expected that these clinical programs will be operational prior to July of this year. Additionally, the Institute will provide continuing education programs with a clinical orientation and foster clinical research of importance to examination procedures, diagnosis and therapies. The Institute will serve as a stimulus to learning and as a model for the delivery of optometric care.



Dr. Mitch Samek, newly-appointed Executive Director

In acknowledging the support and co-operation of the College of Optometrists of Ontario and the Ontario Association of Optometrists, the O.I.T. Board said, "They have fullheartedly supported the concept of the Institute and assisted in bringing incorporation to fruition. The School of Optometry similarly has supported the goals and objectives of an Institute. In addition, more tangible support has been provided by all three; the Association and the College have provided financial support and the School has offered the loan of equipment."

Arrangements are being finalized for the development of our educational/clinical facility in the Danforth and Pape area of Toronto. Approximately 3000 square feet of space have been leased as the initial home of the Institute. Currently, considerable time is being devoted to office and equipment needs as well as to a developmental framework for our future activities.

Dr. Mitch Samek has been appointed as Executive Director of the Institute. Dr. Samek was engaged in private practice for a number of years before returning to graduate school. He received his M.Sc. in 1974, with emphasis in Clinical Epidemiology. Dr. Samek continued his graduate work in the area of continuing education for health professionals, at the University of British Columbia. He joined the faculty of the School of Optometry, University of Waterloo, in 1978. Dr. Samek has published a number of papers in the areas of optometric public health and epidemiology. He is a member of the Ontario Association of Optometrists, The Canadian Association of Optometrists, and a Fellow of the American Academy of Optometry.

The formation of the Institute and appointment of its Executive Director should generate amongst all optometrists excitement and enthusiasm for this opportunity for our profession to enhance its growth and development.

Low Vision . . . from P.80

the practitioner and will result in better care for our visually-handicapped population.

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An Amblyopia That Wasn't

G. Maurice Bélanger*

Fortunately this story has a happy ending. In the many years of its evolving, one must question the depth of the examinations performed and the objectives sought by the many practitioners who attended this patient. The family were military people and travelled extensively in Canada. Optometrists and ophthalmologists both saw the patient over the years. The practitioner consulted just prior to her visit to us was a local ophthalmologist. We cannot say that our findings were not recorded in previous consultations but, if they were, then no recommendations ensued. Somewhere along the line a practitioner, fortunately or unfortunately, used the word "amblyopia" and herein lies the nub of this human story.

The story actually begins in a supermarket where the patient purchased a copy of a women's magazine in which there was published an article on amblyopia, including a post-script to write to the American Optometric Association in St. Louis for details. The theme of the article was that amblyopia could be treated even after childhood. The patient wrote to the A.O.A., requesting names of practitioners in her area who could help her. The A.O.A. sent to the letter to the Ontario Association in Toronto and eventually the patient sought our services.

The main purpose of the visit was to find a cure for her amblyopia so as to provide a "reserve eye" in the event the good left eye were damaged or lost from disease or injury. There was no vocational motive behind her visit nor was there any pre-employment factor.

*O.D., Ottawa, Ontario

L.C. had obtained her very first pair of glasses at age ten. Never, to her knowledge, had the eye turned. She could not recall the date on which the diagnosis of amblyopia, right eye, was given. As far back as she could recall, vision in the right eye had been poor.

We explained in some detail the nature and possible causes of amblyopia, and the procedures and the time involved in amblyopia training. She was made to understand that a *cure* could not be promised, that after a period of training if results were not satisfactory we would discontinue the training. The patient, satisfied with these explanations, requested that we carry on. The examination's findings follow:

Initial Examination

age 28
Rx in use:
OD -2.75 -2.25×80 giving 20/200
OS plano -0.75×150 giving 20/20
tempered photogrey lenses.
uncorrected vision: OD 20/300 by frowning
OS 20/20
cover test — alternate cover — esophoria, more evident with OS
push up: O.U. deviated at 4 inches and diplopia reported
keratometer:
OD $42.50 \times 20 — 45.00 \times 110$
OS $43.50 \times 175 — 43.75 \times 85$
Static Retinoscopy:
OD -7.00 -3.25×20
OS -0.75 -0.75×180
Dynamic Retinoscopy:
OD -6.25 -2.50×20
OS $+1.00$ -0.75×180
Subjective:
OD -7.00 -3.25×20 giving 20/25 minus
OS plano -0.75×150 giving 20/20
Phorias:
far ½ exo
near 8 exo
Ductions far:
adduction 12/18/7
abduction 16/3
Near acuity with correction at 16 inches: 20/40−, 20/30, 20/30+
Distance binocularity: 4 Dot Test through the subjective gave 4 dots, lower red dot was slightly oval, both red dots (O.D.) oscillated very slightly.

From these findings it was evident that the patient was not amblyopic and that, as a youngster, she must have enjoyed good vision in both eyes otherwise it would not have been possible to obtain 20/25− by the simple application of an ophthalmic lens over the "bad eye".

It is difficult to understand why the patient was never told the true condition of her eyes. Surely any practitioner would know enough to use the retinoscope and this would have disclosed the marked anisometropia. It may be that the condition was discovered by someone who was afraid to "tackle" what appeared to be a tough case. Practitioners must always be alert to the possibility that a patient may be unknowingly reporting a false situation; the practitioner should do an objective examination on every patient.

To say the least, the patient was more than overjoyed and surprised at the results obtained. Treatment procedures were discussed as well as the options that were available. It was recommended that a soft toric lens was the most practical solution.

In conditions of marked anisometropia one should always suspect a possible aniseikonia. If the myopic condition is essentially axial in origin, unilateral correction by a contact lens would tend to increase the eikonic problem. The practitioner must evaluate the potential effects of an aniseikonia on binocular comfort against the poor cosmetic appearance inherent in such spectacle lenses and the induced prism effects arising from eye movements behind lenses of significantly dissimilar powers. It was felt that in recent years this patient could not have enjoyed true binocular vision due to lack of acuity in the right eye. It seemed a lesser risk to recommend correction by a contact lens rather than by spectacles.

Treatment procedures

O.D.: front toric, truncated: 8.40/12.8 by 12.0/−8.50 +3.00 × 110

O.S.: no correction

a spectacle overglass for driving and for near when required was prepared in photogrey lenses:

O.D. plano

O.S. plano −.75 × 150

The patient adapted readily to her soft lens. One lens change was necessary to stabilize the cylinder axis.

Progress visit September 1978

distance acuity:

O.D. 20/25 with contact lens

O.S. 20/15 no correction

near acuity:

O.D. 20/40−

O.S. 20/30+

O.U. 20/30− not quite a 20/25−

We have no explanation for the decrease in acuity at near other than to suspect some binocular problem such as an aniseikonia and/or low range fusional amplitudes.

Patient reported that monocularly, the image of the right eye appeared taller. The front toric could account for this. As she was asymptomatic no effort was made to correct it, particularly as eikonic spectacles were the only remedial measure. A small vertical phoria was noted but slight displacement of the contact lens could account for this. Again because of the absence of complaints or discomfort no changes were made.

Progress visit December 1981

Patient was seen for her routine contact lens checks and for two full examinations in May 1980 and December 1981. The pertinent findings of this last visit follow:

distance acuity:

O.D. 20/25 with contact

O.S. 20/20 no correction

near acuity:

O.D. 20/80

O.S. 20/20

over refraction: O.D. only −.25 −.25 × 15

regular subjective refraction O.S. only +.50 −.50 ×170

phoria: far 2 exo, near 5 exo

Adduction:

far x/18/12

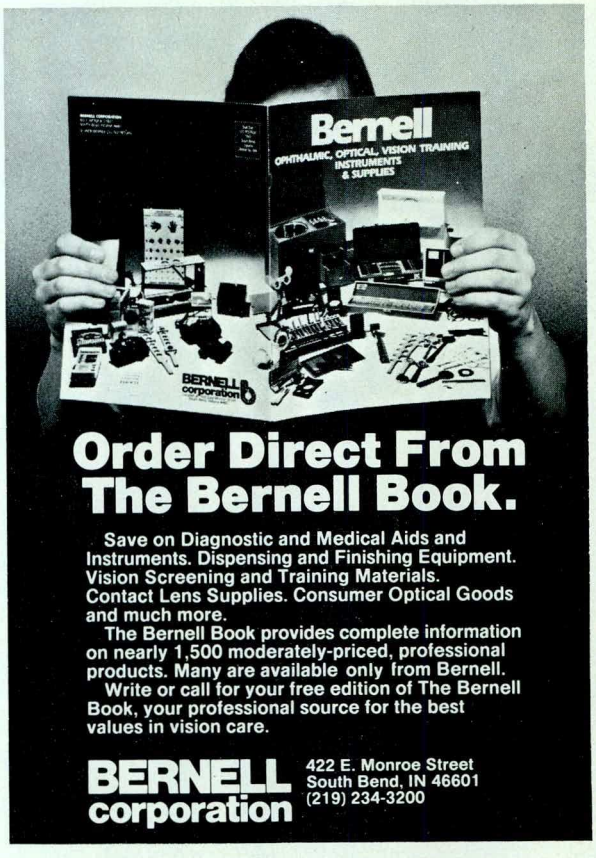
near ?/7/-4

Abduction: far 7/0

near ?/10/7

Again we have no explanation for the drop in near acuity while maintaining far acuity (if readers can provide a clue, the writer would appreciate hearing from them).

The patient uses her distance overglass only for driving or when the sun is too strong for comfort.



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Helps restore worn lenses

Significant improvement was noted even in lenses which had visible deposits when the study began. A decrease in deposits was visually apparent; improved lens comfort and visual acuity were noted by patients.[1]

Increases comfort during wear

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Toronto, Canada L5N 2B8

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Case Report: Vision Training For National Hockey League Goaltender, Rogatien Vachon

Carol C. Dalziel*

Abstract

This non-strabismic patient had an insignificant refractive error, a small esophoria, low fusional vergences, no fixation disparity and symptoms related to and interfering with his goaltending. Compared to his right eye, his left demonstrated slower motor responses, unsteady fixation and a tendency to overshoot with version, vergence and reading tasks on an Eye Trac instrument. A vision training program was designed to encourage faster and more accurate symmetrical and asymmetrical vergence changes, version and tracking eye movements, and accommodative facility. After three months of daily exercises, binocular coordination and goaltending performance had improved and symptoms were relieved.

Abrégé

Ce patient ne souffre pas de strabisme. Son examen révile une réfraction peu significative, une esophorie minime, aucune disparité de fixation mais des symptones associés à son travail de gardien des buts d'une équipe de la Ligue National de Hockey.

Une analyse photographique des mouvements oculaires par "Eye Trac" démontre une performance inférieure de l'oeil gauche: réponse motrice plus lente, fixation moins stable et une tendence ésophorique sur les versions et vergences et dans la lecture.

Un programme de rehabillitation lui a été préparé pour faciliter la rapidité et efficacité des changements de vergence tant symmetriques qu'asymmetriques; des mouvements de versions et de poursuite, et de l'accommodation.

Trois mois de pratiques quotidiennes ont amelioré la vision binoculaire et amené la disparition des symptomes et restauré sa performance de gardien des buts.

*Optometrist, Graduate Student, F.A.A.O.

Case History

Rogatien Vachon, a 34 year old caucasian, was known as the highest paid and the most successful goaltender in the National Hockey League. He had just completed a rather indifferent series when he presented himself for an oculovisual assessment at the University of Waterloo, School of Optometry. The press said long shots were beating him. He complained that his 'vision blurred when concentrating intensely and moving his eyes quickly from place to place'. He felt 'dizzy when the action of the game was fast'. He had no history of spectacle wear, diplopia and ocular surgery or disease. His general health was good. An ophthalmologist diagnosed him as healthy three months before. Twice in the past year puck injuries to his left temple gave him concussions. In response to his symptoms, his physiotherapist gave him many coordination exercises, one of which was to watch his finger moving towards his nose. Ken Dryden, also a goalie in the National Hockey League, had advised him to come to the University of Waterloo, School of Optometry.

Ocular Examination

Examination revealed unaided visual acuities of 6/6+ for both eyes with a subjective refraction of plano O.U. His amplitude of accommodation was 7.75D O.D. and 7.50D O.S. using Sheard's technique. Binocular plus and minus acceptance were +2.50 DS and −1.75 DS respectively. Pupil reflexes responded briskly. Internal and external ophthalmoscopic examination revealed no abnormality. A scar was visible on the left temple. Intra-ocular pressures were within normal limits. Visual fields extended beyond 120° and 150° along the 90 and 0-180 meridians.

Binocularly he had 4^{Δ} esophoria at 6m and .4m by Von Graefe technique. Fusional reserves using rotary prisms were x/8/5^{Δ} B.I. at 6m and 12/18/12^{Δ} B.I. at .4m. Suppression occurred with 24^{Δ} B.O. at 6M and with 21^{Δ} B.O. at .4m. His gradient ACA was 3^{Δ}/1D. He did not report a fixation disparity on Mallet or AOCO vectographic targets either at 6m or .4m. His stereoscopic threshold was 60 sec arc at 6m on the AOCO vectographic slide, 40 sec arc at .4m on Stereofly and Randot tests and 63 sec arc on the Random Dot E. Testing accommodative facility[1a], Rogie was unable to clear a −2.00 DS stimulus to accommodation. Eye Trac traces revealed that the left eye responded more slowly than the right and overshot upon a change in fixation. The left eye fixated unsteadily (Fig.1).

Such small eye movement abnormalities, while not interfering with ordinary visual tasks, did so with the level of performance required for his occupation. As goaltender he was required to make fast and accurate symmetrical and asymmetrical vergence changes, respond quickly to visual stimuli, coordinate vergence, version and tracking eye movements and change accommodation quickly and accurately. He demonstrated problems in all of these areas.

Vision Training Program

A vision training program was designed to treat these specific binocular anomalies. The first two exercises of four originated with the author. The training exercises were designed to stimulate as many of the neurological systems required for

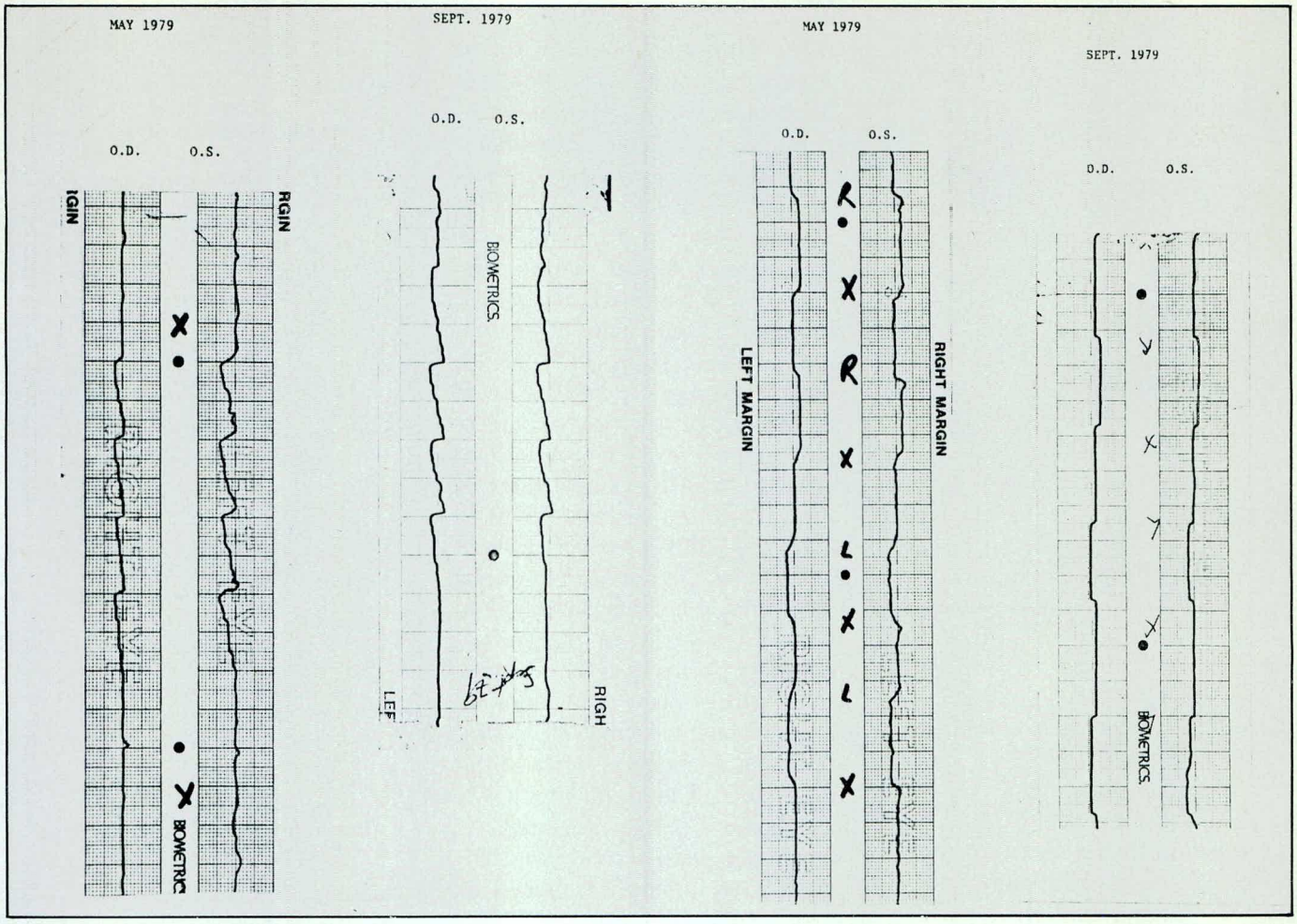

Fig. 1

The figures show Eye Trac traces recorded before and after the vision training program. The before training traces (May) show the left eye had a delayed response when changing fixation in comparison to the right eye. The left eye also overshot markedly when changing fixation and demonstrated an inability to maintain steady fixation of the target. The after training traces (Sept.) show the left eye no longer responded more slowly than the right eye when changing fixation. The left eye maintained steady fixation and did not make overshoots when changing fixation.

the performance of goaltending as possible. Goaltending involves, among many things, fine body balancing on skates. Ample evidence exists relating the regulatory role of the horizontal vestibulo-ocular reflex to eye movement control in the cerebellum[2-5]. Cerebellar climbing fibres relay with cells receiving vestibular, visual and neck information[6-9]. For these reasons a balance board was included in the training exercise procedures to enhance vestibular stimulation, and mimic to some extent the stimulus conditions present when balancing on skates.

The first exercise trained quick and accurate saccadic fixation. Forty-five 35mm slides were developed consisting of single Snellen letter E's, each oriented and positioned differently when projected. The sequence was randomly ordered and re-arranged daily. The patient stood on a balance board 30 ft in front and to the right of the projected area. Wearing his goalie mask and without moving his head, he fixated each letter E, noting aloud the orientation. Initially slides changed every 2 seconds. After some weeks, they were changed once a second. This procedure was repeated 30 ft in front and to the left of the projected area to train right versions. It was repeated with a variation. The patient inserted loose prisms bases out of magnitudes 5, 10 and 15$^{\Delta}$ before each eye. The patient fixated each letter E, moving only his eyes and inserted prism base out, fused the images, and then withdrew the prism before the next letter appeared. This trained saccadic fixation and asymmetrical vergence. A second variation of this involved using −2.00DS lenses before both eyes. As each letter appeared he fixated it, inserted the lenses, focused the letter and then removed the lenses before the next letter appeared. By quickly altering the stimulus to accommodation, accommodative facility was trained (Fig.2).

The second exercise trained fixation. Letter E's mounted on plexiglass plates before two lamps provided the accommodative stimuli. Again the patient balanced on a board and wore his mask. One light was positioned 20 ft in front while another was 30 ft to the right or left of the patient. Independently, each lamp was illuminated intermittently by inserting a Rodale flasher between socket and bulb. Without moving his head, the patient fixated the letter illuminated at that moment. Right and left versions were

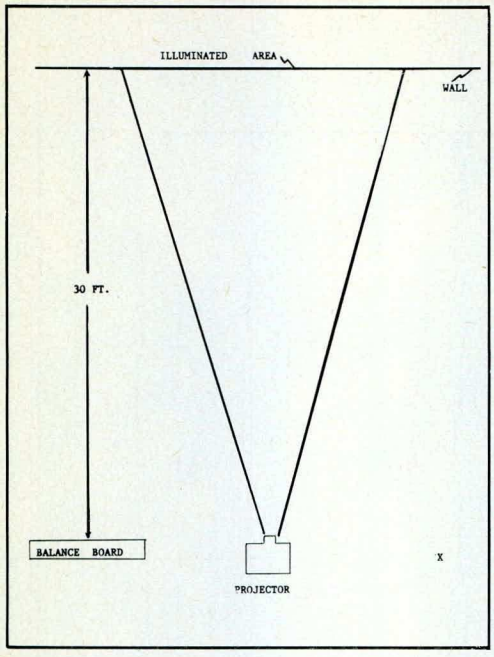

Fig. 2
This diagram presents the position of training equipment for the first exercise. The exercise is designed to train the eyes to make quick and accurate fixation movements.

trained in this manner (Fig.3). The third and fourth exercises were jump ductions[1b] for accommodative facility training and the Biopter for motor and sensory fusion training.

Exercises were prescribed twice daily. Due to the exceptional distance from the School to the patient's home in Los Angeles, there was only one visit other than the diagnostic examinations before and after the training program. During this visit, exercises were explained and demonstrated. Progress was monitored by telephone.

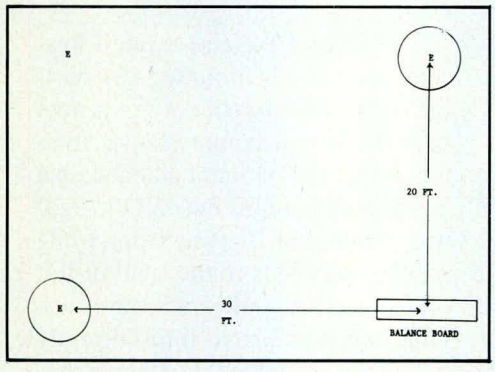

Fig. 3
This diagram presents the position of training equipment for the second exercise. The exercise trains the eyes to fixate quickly and accurately targets which flash randomly.

Results

The patient complied with the therapy, exercising two hours daily. His compliance was exceptionally good. Many patients, given home training over such a long period of time, would not have kept to the schedule. After three months of at-home training he was re-examined. Rogie felt his tennis and golf games, which he played in the off-season, had improved. He was able to see 'better' and more 'clearly' and was 'more aware of his eyes'. His binocular findings were now 1$^{\Delta}$ esophoria at 6m and .4m. His fusional reserves were x/12/10$^{\Delta}$ B.I. and x/30/25$^{\Delta}$ B.O. at 6m and x/24/16$^{\Delta}$ B.I. and x/40+$^{\Delta}$ B.O. at .4m. He did not experience either blur or breaking of fusion up to 40$^{\Delta}$ B.O. which were the limits of the rotary prisms used for measurements. His gradient ACA ratio and binocular plus and minus acceptance remained unchanged. He still did not report a fixation disparity. Accommodative facility measured one second per cycle for both eyes. His stereoscopic threshold remained the same at 6m but improved to 20 sec arc on the Stereofly and Randot tests at .8m, and 53 sec arc on the Random Dot E test. Examination of Eye Trac traces showed both eyes now had similar reaction times. The left eye had steady fixation and no longer made overshoots (Fig.1).

Conclusions

Therapy was effective in producing a level of binocular coordination wherein both eyes performed more equally. Accommodative facility and fusional ranges improved. Suppression no longer occurred with introduction of base out prism. Even stereoscopic discrimination improved. The patient reported relief of symptoms and subsequently improved his goaltending performance.

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***Note:** Special thanks to Provincial Vision Conservation Committee Members:
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The Contribution of the Crystalline Lens to Chromatic and Spherical Aberrations of the Eye

Jacob G. Sivak*

Abstract

The longitudinal chromatic aberration of the eye is greater than expected from reduced eye calculations. Recent evidence shows that this is due to the fact that chromatic dispersion of the crystalline lens is greater than previous estimates, particularly at wavelengths below 500 nm. Measurements of spherical aberration of the lens indicate that the aberration is almost absent. Since the eye is known to be quite free of spherical aberration, both the cornea and the lens may be considered to have relatively constant focal lengths for incident light rays of varying separations.

Abrégé

L'aberration chromatique axiale mésurée de l'oeil est supérieure à celle résultant d'un calcul basé sur l'oeil reduit. Des études récentes démontrent que la dispersion chromatique du cristallin dépasse l'ancienne donnée surtout pours les longueurs d'ondes au dessous de 500 NM.

L'aberration spherique mésurée du cristallin est presque nulle. Conséquemment on peut conclure que la cornée et la cristallin maintiennent une distance focale constant pour des rayons incidents à differentes distance de l'axe optique.

Introduction

Numerous investigators, employing a variety of subjective and objective methods, have measured the chromatic and spherical aberration of the eye. Newton[1] is given the credit of being the first to measure longitudinal chromatic aberration. The more recent studies of Wald and Griffin[2], Ivanoff[3] and Bedford and Wyszecki[4] have confirmed that chromatic aberration is substantial and amounts to 2 — 2.5 dioptres between 400 and 700 nm.

Measurements of spherical aberration of the eye are more difficult and the results are less consistent than in the case of chromatic aberration, although efforts to measure it go back at least to the time of Young[5]. Nevertheless, the classic experiments of Ivanoff[6], Koomen et al[7]. and Schober et al.[8] are in agreement in concluding that spherical aberration is highly variable and relatively insignificant in amount. LeGrand[1] writes that "it seems illusory to speak of an average spherical aberration of the human eye; the only general conclusion is that in diurnal conditions spherical aberration reaches at most a few tenths of a diopter . . .". In fact, Jenkins[9] has calculated from schematic eye parameters that 10.0 dioptres of spherical aberration should exist for a 6 mm pupil. The reasons for the relative absence of spherical aberration will be discussed elsewhere in this paper.

Chromatic Aberration of the Crystalline Lens

The relative contributions of the lens and cornea to chromatic (and spherical) aberration is not clear despite the attention which these aberrations have received in studies dealing with the whole eye. In attempting to calculate the chromatic aberration expected from schematic eye values, LeGrand[1] was faced with the problem of assigning refractive indices for various wavelengths to the ocular media. Corneal constringence was assumed to be 56, that of water. The lens was more difficult to deal with. From the sparse data available in the literature[10,11], it appears that the lens is more dispersive than water and a constringence value of 50 was chosen. Even with this value, the calculated overall chromatic aberration of the eye is less than that measured experimentally, the difference being particularly noticeable at the blue end of the visible spectrum; ie. below 500 nm. LeGrand concludes that the lens must be still more dispersive in blue light.

Ivanoff[3] also considered that the lens contributes disproportionately to the eye's chromatic aberration. However, the amount of chromatic aberration which he measured in one aphakic subject (0.75D) is not strong evidence for this view since the average amount measured for normal eyes using the same experiment amounts to 1.25D. Sivak and Millodot[12] measured lens chromatic aberration of four subjects by eliminating the refractive contribution of the cornea. This is accomplished by submerging the front surface of the cornea in water (actually, a net refractive contribution of −1.5D results because the two corneal surfaces are not parallel). Corneal refractive power was replaced with an achromatic lens of appropriate power and location. The results indicate that the chromatic aberration of the lens amounts to 0.5D, or about one-third the average value of 1.5D measured for the same eyes without the water placed in front of the cornea. Since the power of the unaccommodated lens is approximately one-half that of the cornea, these results suggest that the chromatic aberration contributed by the two refractive structures of the eye are roughly proportional to their powers and a difference in dispersion is not indicated.

While these results are quite clear, there is one important flaw. LeGrand emphasizes that it is the blue end of the spectrum (below 500 nm) that is affected by enhanced

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lens dispersion. The Sivak and Millodot study stops at 486 nm due to limitations imposed by the experimental equipment. Thus the amount of chromatic aberration contributed by lens for the critical wavelengths below 486 nm was not measured.

Recently Palmer and Sivak measured chromatic dispersion of animal lenses and one human lens directly by the method of Pulfrich refractometry[13]. This method involves axially bisecting a freshly dissected lens and placing the cut edge on one side of a right angle glass prism. Refractive indices for a variety of wavelengths can be determined by noting the change in critical angle of the prism. Further, it is possible to differentiate between peripheral and central zones of the lens. This procedure included measurements made at short wavelengths (to 410 nm) and the results confirm the suspicions of LeGrand and Ivanoff. Lens dispersion values are consistently greater (or constringence values are consistently lower) than water, with dispersion increasing as a function of depth into the lens. Furthermore, dispersion increases asymptotically toward the blue wavelengths. In fact, the curve showing the change in refractive index between 700 and 550 nm is quite flat while the rate of change increases dramatically toward 400 nm.

A study carried out with two methods, Pulfrich and Abbe refractometry by Sivak and Mandelman[14] confirm these results on larger numbers of human and animal lenses. Constringence values for the lens nucleus can be as low as 35 (cat, human), substantially lower than the value of 50 used by LeGrand for the whole lens. In addition, measurements of corneal constringence are also lower than water although not as much as the lens (45, chicken) with the effect being particularly noticeable in blue light. In fact, corneal dispersion curves suggest that they are a combination of two separate functions, a flatter curve for the longer wavelengths and a steeper one for the short ones.

The results show that the greater dispersion of the lens (and the cornea to a lesser extent) in blue light is responsible for the larger than expected amounts of measured longitudinal chromatic aberration. Thus, one can argue that chromatic aberration, unlike the other aberrations of the eye, is not controlled and is, in fact, exaggerated somewhat. In this context it is important to note that the eye's substantial chromatic aberration is useful in that it is used as a means of sparing accommodation[15,16]. By using the chromatic aberration interval and focussing on long wavelengths with accommodation relaxed and short ones while accommodating, the effort exerted by the ciliary muscle-lenticular accommodative apparatus is minimized.

Spherical Aberration of the Crystalline Lens

That the eye is relatively free of spherical aberration has already been noted. The absence of spherical aberration is attributed to three factors; asphericity (peripheral flattening) of the cornea, asphericity of the surfaces of the crystalline lens[17] and the variation in refractive index of the lens from periphery to core. Little experimental attention has been paid to the relative importance of each of these factors in controlling spherical aberration. Bonnet[18] measured a small amount of positive spherical aberration (shorter posterior vertex distance for peripheral light rays) in one aphakic with a six mm pupil. This suggests that the lens alone must also have little spherical aberration. However, El Hage and Berny[19] concluded, on the basis of corneal topography, that the cornea contributes substantial quantities of positive spherical aberration and this must be neutralized by a lens with negative spherical aberration.

Millodot and Sivak[20] measured lens spherical aberration directly in an experiment in which corneal refractive power was virtually eliminated by means of a saline water-filled goggle. An aspheric glass lens (20D) appropriately placed in front of the eye replaced the cornea. The procedure was based on the Scheiner Disc principle. One eye was occluded while the other was partially occluded with a disc containing small apertures at varying excentricities (1.4 — 3.6 mm) from a central aperture. Only the central and one of the peripheral apertures were open at a given time. A vertical target was seen as double by the subject when an ametropia existed. Loose prisms placed in front of the peripheral aperture to eliminate doubling of the target indicated the value of the ametropia. The magnitude and direction of spherical aberration was found by comparing the results for the different apertures.

The mean result for 20 subjects shows that the whole eye has a small amount (about 2/3 D for the greatest eccentricity) of positive spherical aberration. The amount and, in one case, the sign varies from one individual to another. The lens alone also exhibits slight positive spherical aberration although about half that of the whole eye. Here again, individual differences were noted. In two cases, the aberration was negative. These results indicate that the aberrations of the cornea and lens are not usually opposite in sign. Rather than neutralizing each other, the small aberrations of each structure summate. One can only conclude that both the lens and the cornea are remarkably free of spherical aberration and phenomena such as nocturnal myopia cannot be attributed to it.

Recently (Sivak and Kreutzer, in preparation), spherical aberration of excised human and other animal lenses were determined directly. The method involves projecting a split beam from a helium-neon laser through the lens and photographing its focal effect. By varying the separation of the entering beams it is possible to measure differences in focal length; ie. spherical aberration. Extensive variation in spherical aberration, both positive and negative, was noted for the 5 human lenses examined. Since the lenses

were from individuals of relatively advanced age, it is possible that the ability of the lens to control its spherical aberration deteriorates with age.

Summary

1. The measured longitudinal chromatic aberration of the eye is greater than that calculated from reduced eye parameters.
2. This difference is due to the greater than expected chromatic dispersion of the crystalline lens.
3. Lens dispersion increases asymptotically below 500 mm and therefore the short wavelengths are major contributors to the eye's chromatic aberration.
4. The appreciable quantity of chromatic aberration exhibited by the eye is not necessarily detrimental to vision. For example, it has been shown that the chromatic aberration interval is used to spare accommodation.
5. The eye is relatively free of spherical aberration and it has been suggested that this is due to the fact that the positive spherical aberration of the cornea is neutralized by the negative aberration of the crystalline lens.
6. Measurement of the spherical aberration of the lens *in vivo* indicates that both the lens and the cornea are almost free of spherical aberration. In general, the slight positive aberration of both structures summate.
7. The relative absence of spherical aberration may be attributed to; peripheral flattening of the cornea, the variation in refractive index of the lens from the cortex to the core and the asphericity of the lens surfaces.
8. Direct measurement of spherical aberration of excised lenses from individuals of advanced age demonstrate large amounts of positive and negative aberrations. It is possible that the ability of the lens to control this aberration deteriorates with age.

Acknowledgement

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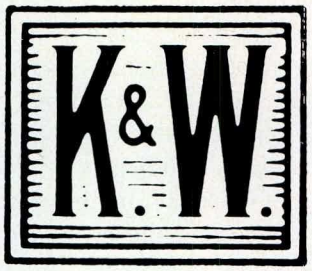

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Case Report — Noncomitant Ocular Deviation

Rodger Pace*

Abstract

The optometrist is often called upon to diagnose and manage the patient with noncomitant ocular deviations. A case of noncomitant phoria is described with emphasis on the Parks 3-step method for identifying the involved muscle. Patient management is discussed.

Abrégé

Il est souvent du sort de l'optométriste et de gérer des cas de strabisme non concomitant. Ce travail décrit une phorie non concomitant et met l'emphase sur le test diagnostique "Parks 3-Step" pour déceler le muscle affecté.

C.N. is a 33 year old high school teacher who requested visual assessment due to asthenopia and blurring of vision while doing near work. Although he had been troubled by this for several years he had never had a professional vision examination prior to this visit. General health history was unremarkable. He reported a brother who had had strabismus surgery when in his late twenties.

Clinical findings

Unaided visual acuity
OD 20/20; OS 20/20; OU 20/20
Amplitude of accommodation
O.D. 8 dioptres, O.S. 8 dioptres
Keratometry O.D. 44.25 @ 180
45.25; O.S. 43.50 @ 180 45.25
Refraction O.D. plano, 20/20;
O.S. +0.50 −1.00 × 180, 20/20

Tests of binocularity

Near point of convergence 6cm
Stereoacuity 40 seconds
(Wirt rings)
Distance phoria (von Graefe):
2 exophoria
Negative fusional vergence 7/0
Positive fusional vergence X/8/6
Distance vertical phoria 1.5 right
hyperphoria
Positive vertical vergence 4/2
Negative vertical vergence 3/1
Nearpoint phoria (von Graefe)
5 exophoria
Negative fusional vergence X/6/3
Positive fusional vergence X/8/0
Near vertical phoria 2 right
hyperphoria
Positive vertical vergence 6/4
Negative vertical vergence 1/−3
Binocular plus acceptance +2.00
Binocular minus
acceptance −2.00

Distance vertical fixation disparity was neutralized by 2 prism dioptres base down before the right eye (Mallet). Near vertical fixation disparity required 6 prism dioptres base down before the right eye.

Cover tests in different positions of gaze revealed a noncomitant deviation so the Park 3-step procedure[1] was done. The following results were elicited:

primary position:	right hyperdeviation
gaze left:	right hyper increased
gaze right:	right hyper eliminated
head tilt left:	right hyper decreased
head tilt right:	right hyper increased

The patient was noticed to have a torticollis toward the left shoulder under normal viewing situations.

Diagnosis

Analysis of the 3-step method isolates the right superior oblique as the muscle of primary involvement. Since the patient's symptoms were long-standing and there was a family history of strabismus it was felt that the deviation was not of recent onset. This is reinforced by the presence of the torticollis.

Management

The following prescription was supplied to C.N.: O.D. plano, 1.5 prism dioptres base down; O.S. +0.50 −1.00 × 180, 1.5 prism dioptres base up. A programme of ocular calisthenics was prescribed to enhance ocular motility and orthoptic training was undertaken to improve fusional ranges. This programme consisted of three office visits at weekly intervals. Each visit consisted of exercises with the rotoscope, major amblyoscope using grade III targets, vectographic materials (such as the Quoit slides), and loose prisms. These sessions averaged forty-five minutes in length. Concurrently, fifteen minutes of home training was prescribed on a daily basis. This included rotations using a penlight with a red lens before one eye to monitor suppression, free fusion using the eccentric circle card, and fusion through loose prisms.

Followup

A reassessment of C.N.'s status was made one month following initiation of therapy. He was wearing his glasses on a full-time basis and reported complete relief from symptoms. Diplopia was not reported and the original asthenopia was relieved. Motor fusion ranges satisfied both Sheard's[2a] and Percival's[2b] criteria for ocular comfort. A programme of home training was advised to maintain fusional amplitudes and ocular motility.

Discussion

Noncomitant ocular deviations often present difficult management problems because of the varying degree of the deviation. The patient often experiences diplopia when the eyes are directed into the field of action of the involved muscle or muscles. The patient will often compensate by turning the head rather than the eyes when looking in the involved direction. An ocular torticollis may also develop to minimize

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the deviation while looking straight ahead. The Parks 3-step method is useful for determining which of the vertically acting muscles is primarily involved, however if a combination of muscles is involved, the Hess-Lancaster screen may be more informative.

The optometrist must first determine whether the deviation is of recent origin as this could indicate a pathology. This can be done by history, patient observation, clinical findings or medical consultation. Therapy can involve occluders, either partial or total, to eliminate diplopia, ocular calisthenics to increase muscle actions, and prisms to allow fusion. Prisms will probably be tolerated best if the deviation in primary gaze is compensated. Fusional reserves can be trained to allow better comfort in other positions of gaze.

C.N.'s case demonstrates that a relatively simple therapeutic regimen utilizing compensating prisms and vision training effectively relieved symptoms of blurring and asthenopia in a patient with a noncomitant ocular deviation.

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Erratum

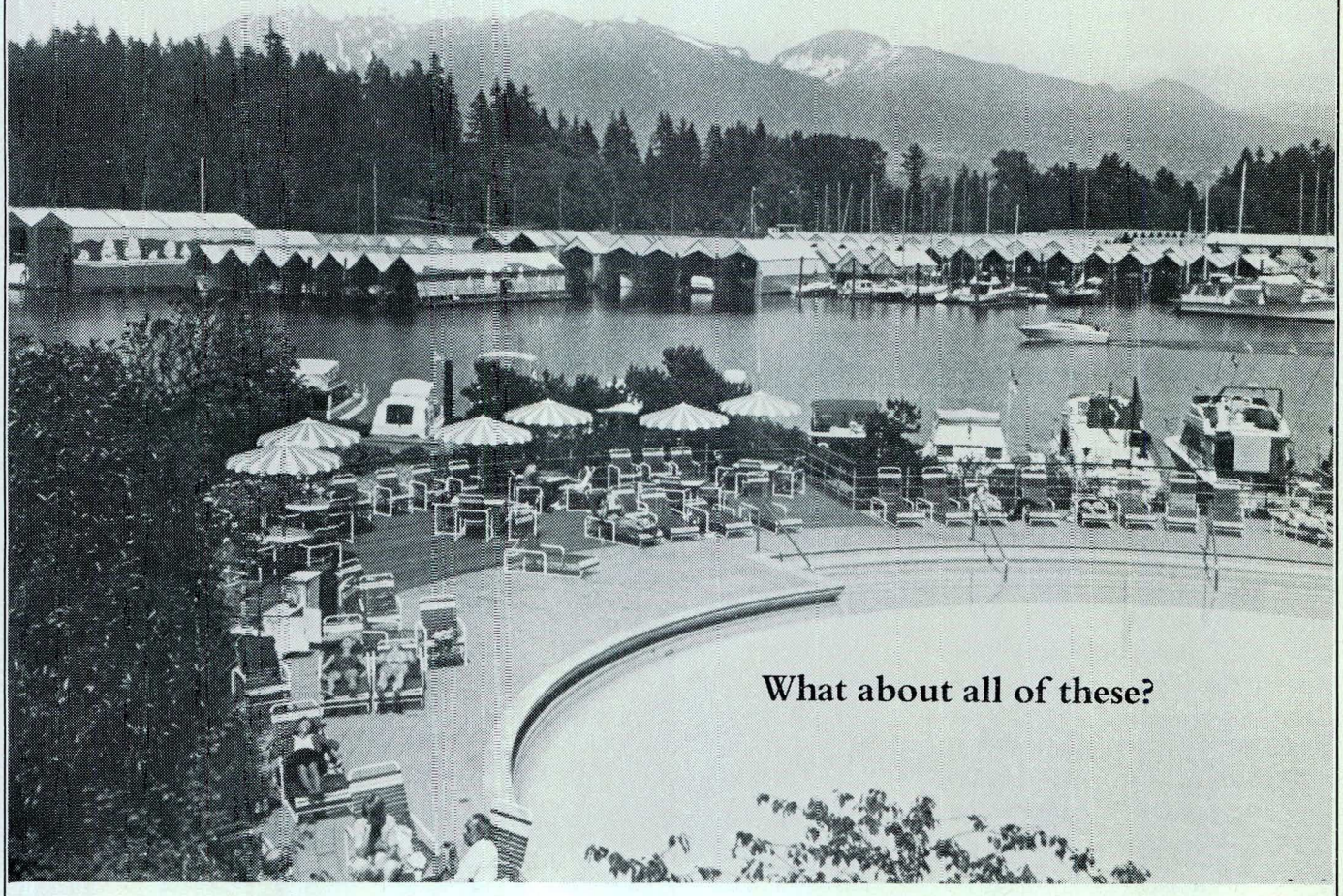
In our supplement to Volume 43, No. 4, devoted to the Canadian Optometric Contact Lens Society, we omitted the following from the list of Supporting Members. We apologize for the error:

Dr. B.S. Beaton
Dr. J-L Blanchard
Dr. H. Drexler
Dr. E. Howe
Dr. D.J. Kerr
Dr. L.B. Kolbenson
Dr. R.B. Leake
Dr. O.E. Panchuk
Dr. L.V. Selvig

In addition, our apology to Dr. G.J. Pearce, whose name was spelled incorrectly in the issue.

Where will you be this time next year?

. . . in the mountains?
. . . by the ocean?
. . . seeing old friends?



The 1983 C.A.O. 18th Biennial Congress is being hosted by the British Columbia Optometric Association in scenic Vancouver, July 4-8, 1983 at the beautiful Bayshore Inn. Why not schedule a few days in Canada's "Pacific Paradise"?

Plan *now* to attend!

Case report: Diagnosis of a double hyperphoria

Nicole Lapierre*

A double hyperphoria problem is a form of strabismus characterized by the upward deviation of the line of sight of either eye while the other fixates.[1] Various terms have been employed to describe this condition: "alternating sursumduction", "dissociated vertical divergence" and "occlusion hypertropia".[2] It is frequently associated with overaction of the inferior oblique muscles and infrequently with latent nystagmus.[3] The hyperdeviation is often different in the two eyes and the amplitude is usually difficult to measure. On performing the cover test, the occluded eye rotates upward, often with extorsion; with removal of occlusion, the eye moves down, often accompanied by intorsion.[4] This phenomenon occurs in a patient with otherwise normal binocular vision or in association with other types of visual anomalies.[2] Its etiology is obscure at the present time.[2] Hugonnier[4] states that this anomaly is present in 10% of all strabismics. Surgical treatment is unpredictable; a few authors have advocated a weakening procedure of the elevators.[3]

History and findings

Patient R.S., age 10, was complaining of blurred vision at distance for the left eye but was not reporting any difficulty at near. Family history was free of any health problem, eye disease, or squint. The patient reported that sometimes he had the impression that one eye tended to go up (with fatigue or during day-dreaming). No previous eye examination.

Present RX: None V.A.: O.D.: 20/40
O.S.: 20/40

Refractive examination showed:

O.D.: +0.25 (−1.25) 15° V.A.: 20/20
O.S.: +0.25 (−1.00) 165° V.A.: 20/20−

Internal and external examination showed no sign of pathology in either eye. Pupillary reflexes and central fields were normal O.U.

The unilateral cover test performed at near and at distance revealed a hyperphoria recovery movement in each eye upon removal of the occlusion. Binocular testing revealed the presence of binocular vision. The following results were obtained on the von Graefe ductions tests:

at 6 m 1$^{\Delta}$ Exo
B.I. x/10/6 B.O. x/8/4
at 40 cm 5$^{\Delta}$ Exo
B.I. x/14/10 B.O. x/10/4

Stereoscopic testing (Titmus fly) was found to be 100 seconds of arc. However, with the red glass diplopia test, the patient reported seeing two images, the red one below the light (red glass in front of O.D.) and the same response was obtained when the red lens was placed on the L.E. On the Maddox rod test performed at 40 cm, the horizontal and vertical deviations were measured with the prism bar to be 4$^{\Delta}$ of Exo and 4$^{\Delta}$ to 8$^{\Delta}$ Hyper, respectively (O.U.).

On the examinations of the levo — and dextro — versions with the Hirschberg test the eyes showed no deviation. In the extreme superior fields, the versions were slightly abnormal (possible overaction of the inferior oblique muscles).

Conclusion:

The diagnosis of double hyperphoria was made on the basis of the hyper present in each eye upon covering of either eye and the cylinder correction was prescribed. The patient was instructed to return if any problem (squint, diplopia;. . .) would appear with the wearing of the Rx. Orthoptics was not suggested to this patient at the time of the evaluation since the patient did not have any problem with school work and never complained of double vision that could be more likely to happen in this particular case. As success in V.T. depends on many factors, an important one being the patient's motivation, the author did not really feel, in this case, the need for V.T.

However, orthoptics have been advisable in similar cases where suppression and/or alignment problems were associated with the double hyperphoria and where the patient was experiencing discomfort, especially for close work. Since these problems are sensory but not motor, anti-suppression therapy and fusional therapy are highly effective.

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Simplification of the Bielchowsky head tilt test for the general practitioner

Nicole Lapierre*

Abstract

The following is a short, but nonetheless important idea in orthoptics. It has the potential of not only facilitating a difficult part of exam questioning but also of simplifying an examination technique for the practitioner.

Abrégé

Cet article présente une procédure d'examen simple, mais néanmoins importante du bilan orthoptique. Cette technique a non seulement l'avantage d'être utile à une partie plus difficile de l'anamnèse mais aussi de simplifier une technique d'examen pour le praticien.

The Bielchowsky head tilt test[1,2] helps us to diagnose the offending muscle (vertical or oblique) in paralysis or paresis of long standing. Because of the secondary contractures taking place in the antagonist, the yoke muscles and their antagonists, the deviation may become increasingly concomitant, after which the difference between primary and secondary deviations decreases or disappears. As the result of these changes, conventional ocular motility testing becomes useless or frequently yields equivocal findings. Consequently, the diagnosis of the defective vertical or oblique muscles must be based on their antagonistic action during supraduction and infraduction and their synergistic effect during incycloduction and excycloduction[2].

Physiologic principles

The physiologic basis of the head tilt test was explained by Hofmann and Bielchowsky[3], who also fully confirmed this theory on clinical grounds. The head tilt phenomenon can be briefly explained as follows[2]. When the head is moved around an anteroposterior axis, compensatory eye movements occur around an antereposterior axis of the globe because of reflex innervation originating in the otolith apparatus. Thus, when the head is tilted to the right, the right superior oblique and rectus muscles contract to provide incycloduction of the right eye. In the left eye the left inferior oblique and rectus muscles contract to effect excycloduction of that eye. Analogously, cycloductions occur in the opposite direction when the head is tilted to the left. The compensation of the head inclination by wheel rotations of the eyes is incomplete and does not fully offset the angle of inclination.

Muscles that act synergistically during cycloductions become antagonists when elevating and depressing the globes. Under normal conditions, however, the vertical action of the rectus muscles exceeds that of the oblique muscles, and conversely, the effect of the oblique muscles on cycloductions is greater than that of the vertical rectus muscles.

When the head is tilted toward the involved side in a case of right superior oblique paralysis, the vertical and adducting action of the RSR is unopposed. Contraction of this muscle in an attempt to incycloduct the eye results in an upward movement of the right eye (positive Bielschowsky head tilt test), thus increasing the vertical deviation.

The Three-Step Method

Parks[4] popularized this diagnostic scheme by suggesting the three following questions to determine the paretic muscle: (1) does the patient have a right or left hypertropia in primary position? (2) Does this deviation increase in adduction or abduction? (3) Does it increase with the head tilted to the right or left shoulder? This test is usually performed objectively (Hirschberg method, prism cover test, etc.), but it can also be done subjectively. Using this three-step method, one can distinguish a paretic oblique or vertical rectus muscle in most instances. A table elaborated by Griffin[5] summarized the results for each step and for any given vertical or oblique muscles.

However, for the student and for the general optometrist, who doesn't use the test routinely, it is difficult to take the data obtained from the three cover tests and come up with the deficient muscle. To make the diagnosis without a table takes not only command of the anatomy, but also a logical deduction of

Table 1 The three-step method

Step 1	step 2	step 3	paretic muscle
R	R	R	L.I.O.
R	R	L	R.I.R.
R	L	R	R.S.O.
R	L	L	L.S.R.
L	R	R	R.S.R.
L	R	L	L.S.O.
L	L	R	L.I.R.
L	L	L	R.I.O.

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which muscle does what in which position. To come up with the right muscle not only takes time but with one slip, it is easy to isolate the wrong muscle. With a patient to analyze, it is time consuming and potentially confusing.

The simplified method

To simplify this method, Schwarting[6] patented a computer to indicate the correct muscle according to a three step method approach almost identical to that of Bielchowsky's. An elaborate and efficient system but of no need to the practitioner. More recently, Koch[1] presented a system to make the Bielchowsky head tilt test simple to interpret. With this system, it is no longer necessary to think out what is going on with respect to intortion, elevation, etc. but only to follow three simple steps. It should be noted here, that although it is of great help to use this method, one should be aware of what is going on just the same.

The starting point is a diagram of the two eyes of the patient with the vertical fields of action of the muscles indicated (figure 1). It should be noted that the recti work into their like field and the obliques into their opposite. Therefore upward gaze to the right requires the R.S.R. and the L.I.O.

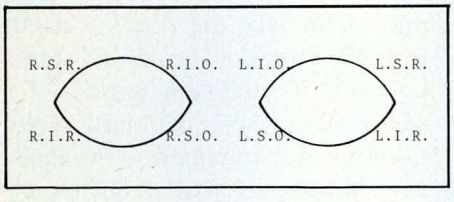

Figure 1 — Starting diagram

In this simplified method, there are also three steps:

Step I: Vertical deviation: circle the two muscles opposite to the vertical deviation in each eye;

Step II: Horizontal field of worse deviation: determine the version (right or left) with the greatest hyper deviation and circle the four muscles on the same side;

Step III: Direction of head tilt going toward the worse deviation: determine the head tilt to the right or left with the greatest hyper deviation and circle the two muscles of each eye in the same axis as the patient's face.

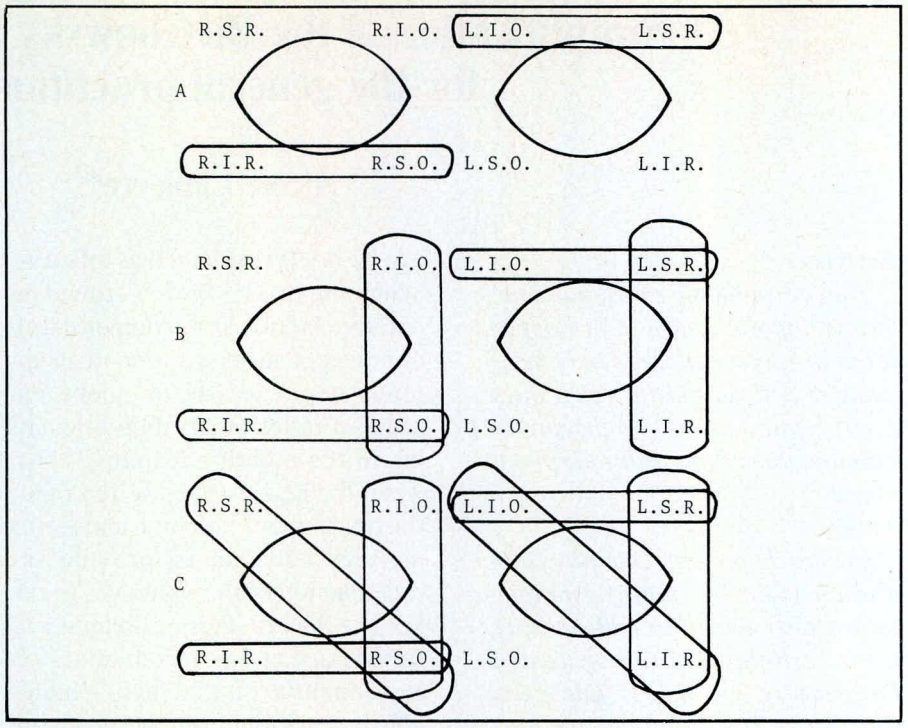

Figure 2 — Hypoaction of the R.S.O.

For example, in a patient with a right hyper (left hypo), one circles the right depressors and the left elevators (figure 2a). If the deviation is greatest to the left, step II tells us to circle the right obliques and the left recti (figure 2b). Finally, if the deviation is greatest with the head tilted to right (step III), one circles the R.S.R. and the R.S.O. of the right eye (intorders) and the L.I.O. and the L.I.R. (extorders) of the left eye (figure 2c).

Examination of the completed diagram will show only one muscle which is circled three times, that is the hypo-active muscle. In this example, it is the R.S.O. which is indicated. This system works for any combination and has no exceptions. From our clinical experience this procedure is extremely fast and simple. No deductions, calculations, or referring to tables is required. Everything is done on the diagram and at the end, one has a written record of what was done. It also helps to predict preferred head position of the patient since it will be opposite to the circles made on the diagram in steps two and three. (In this example, head to the left shoulder and looking toward the left or gaze to the right).

Simple interpretation makes any test more viable in a clinical situation. This new way to work through the head tilt test may make it less intimidating to optometrists in general practice.

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Abbreviations used:

R.I.R.	right inferior rectus
R.S.R.	right superior rectus
R.S.O.	right superior oblique
R.I.O.	right inferior oblique
L.I.R.	left inferior rectus
L.S.R.	left superior rectus
L.S.O.	left superior oblique
L.I.O.	left inferior oblique

Cyclopegic Versus Manifest Refractions

Gordon Hensel*

With the precedent set by the New Brunswick Optometric Association and upcoming changes in drug legislation in several western provinces; optometrists across Canada are becoming increasingly aware of the use of diagnostic pharmaceuticals. The following report compares the refractive status of 423 eyes when examined by manifest and cycloplegic refractions. The subjects ranged in age from 2 to 89 years, and 62% were female.

Each patient had a manifest refraction performed by the author. The patient then received 2 drops of 1% tropicamide (Mydriacyl) O.U., and the refraction was reperformed by the same practitioner 20 to 25 minutes later. Table 2 shows the average difference between cycloplegic and manifest refractions.

Tropicamide is a rapidly acting antimuscarinic drug. It inhibits the action of acetylcholine on structures innervated by postganglionic cholinergic nerves and acts on muscarinic receptors. Tropicamide has a short duration of action, therefore, one must be careful that the refraction is performed during the time interval which is 20 to 25 minutes after instillation.

According to Havener[1], residual accommodation should not exceed 2.00 D for a satisfactory cycloplegic refraction. After the instillation of 1 drop of 1% solution of tropicamide, he found varying degrees of residual accommodation, but with 2 drops of 1% solution of tropicamide O.U. he found all eyes met the above requirements. Therefore I used 2 drops of 1% solution of tropicamide O.U. in this study.

TABLE 1

Makeup of Each Group in Table 2

Group	Dioptric		Values
A	greater than		−6.12D
B	−4.12D	—	−6.00D
C	−2.12D	—	−4.00D
D	−0.12D	—	−2.00D
E	+0.12D	—	+2.00D
F	+2.12D	—	+4.00D
G	+4.12D	—	+6.00D
H	greater than		+6.12D

TABLE 2

Average Difference Between Cycloplegic and Manifest Refraction

group	A	B	C	D	E	F	G	H
no. in group	19	35	80	98	143	30	14	4
average change	+0.27	+0.14	+0.02	0.00	−0.02	−0.20	−0.30	−0.41

It can be seen by the data in Tables 1 and 2 that not only is a manifest refraction less than a cycloplegic refraction in high hyperopes as would be expected, but surprisingly, it is also less in high myopes. A plus sign indicates a cycloplegic refraction higher than a manifest refraction and vice versa for a minus value. This means that a +5.50 cycloplegic will show as a +5.00 manifest; or on the other hand, a −5.25 cycloplegic will show as a −5.00 manifest. These differences must be kept in mind before a final prescription is written (remembering that a refraction is by no means the final prescription).

This study represents a clinical sampling only. Since tropicamide tends to have a greater mydriadic than a cycloplegic effect, perhaps further research might attempt to differentiate the role of mydriasis compared to cycloplegia in producing the results observed in this study.

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A Precision Instrument for the Clinical Measurement of Stereoscopic Acuity

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Abstract

When tested by different methods, a patient's stereoscopic acuity is seldom the same. This raises the question as to which one gives the true stereoscopic acuity. To answer this, a programmable test for stereoscopic acuity was designed to serve as a testing standard. This is described and a comparative study with it and four other tests is reported.

Abrégé

Différents tests d'acuité stéréoscopique donnent rarement les résultats identiques même pour le même sujet. Il est donc question de savoir lequel des tests donne un résultat véridique. Ce travail décrit un nouveau test basé sur un programme d'ordinateur, qui servirait comme un test étalon. Une comparaison de ce nouveau test avec quatre tests déjà existants est incluse.

Tests to determine the quality of stereopsis can be used for the clinical evaluation of visual function.[1] This is because the perception of depth through stereopsis is best only when there is good acuity in both eyes[2,3], when fixational errors are insignificant[4] and when integration at the cerebral cortex is complete[5]. The quality of stereopsis is usually expressed in terms of the least binocular disparity which can be detected as a difference in perceived depth[6]. This is called stereoscopic acuity and for observers with perfect vision, it is found to be in a range of from 2 to 8 minutes of arc[7]. Values greater than this can usually be attributed to an imbalance of visual acuity, oculomotor imbalance or to some degree of suppression[7]. Stereoscopic acuity is unique in that it is an indicator of the overall quality of binocular vision.

At present, stereoscopic acuity is of limited clinical use. As Scott and Marsh stated, "the inability to ascertain individual differences in stereoacuity beyond a certain level limits or precludes some potential applications of the measure"[8]. This limitation came to our attention because we had the opportunity to test the same persons with a number of currently available tests. If each test were equally valid, one would expect that similar results would be found. This was seldom the case. In addition, the least disparity in the test was usually too great to test for normal stereoscopic acuity.

Superficially, most manufactured tests for stereoscopic acuity appear to be of some use. It has been our experience that tests new to us have always seemed worthwhile. With experience, our opinion has changed for the worse and in some cases we have finally concluded that a test was worthless.

One of us (Larson) undertook to study the design and construction of stereoscopic acuity tests with the objective of finding one which could be relied upon for clinical use. Ultimately, it was deemed necessary to design and construct a test based on the principles enunciated by Howard in 1919[7]. Howard's test (which is *not* the same as the Howard-Dolman) is beyond reproach from a scientific point of view but is not suitable for clinical use because it is too slow, occupies too much space and cannot detect certain anomalies of stereopsis. These defects have been overcome by changes in the test's design and by the use of automation and computer control. The result is a precision test for stereoscopic acuity which is an effective clinical test and is a standard against which other tests can be judged.

Early tests for stereoscopic acuity (developed in the 19th century) presented retinal image disparities by means of a stereoscope. Howard observed that these tests were unreliable. Therefore, he devised a test in which real objects (two parallel vertical rods) positioned in real space (at a distance of 6 meters) produced the disparities. He screened the ends of the rods from view so that all monocular distance cues were eliminated. He used pilots in the American Air Force as subjects and his results showed for the first time that the limit of stereoscopic acuity is about 2 seconds of arc. He also observed that an acuity of more than 8 seconds was associated with some sign of oculomotor or visual acuity imbalance. He concluded that perfect stereoscopic acuity was 8 seconds of arc or less.

Most tests in use today present disparities stereoscopically. We suggest that this is done more for reasons of marketability and ease of manufacture than for the production of an effective test. With the advent of vectographs, tests which previously required a stereoscope could be performed with polarized glasses. Unfortunately, the plastic film of the vectographs was not sufficiently stable to permit the presentation of the smaller disparities. The least disparity which can be maintained is not known to us but commercially available vectographs have a least disparity of 20 sec. or more. Tests printed on paper are also subject to instability due to expansion and contraction, particularly with changes in humidity.

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One test printed on paper claims to present a disparity of 3.6 sec. If this were possible, a dimensional difference of 0.0035 mm (0.00014 inch) would have to be maintained. To say the least, this claim is unrealistic.

Howard's test was reliable because real objects in real space were used to produce the desired disparities. Because no lenses, prisms, mirrors, filters or polarizers were used, there was no possibility of them modifying the results. Because the dimensions of the apparatus were large enough to be measured easily, the accuracy of disparities could be verified with precision.

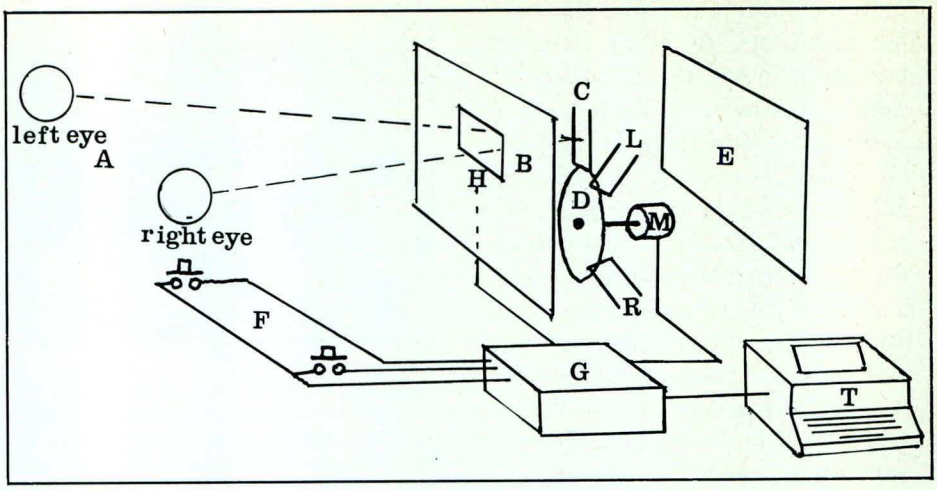

Fig. 1.
Sketch showing the elements of the automated stereoscopic acuity test. The patient (A) looks through a window in a plate (B) at a pair of pins (C) mounted on a disc (D). These are seen in silhouette against an illuminated surface (E). The pins (C) being equidistant from the observer, he presses both switches (F) at the same time. The computer (G) then closes the shutter (H) and causes the motor (M) to turn so that another pair of pins will be seen when the shutter opens. If the left pin is nearer (L) the left switch is actuated, if the right is nearer (R) the right switch is actuated. When the test is completed, the results are typed out by the terminal (T).

DESCRIPTION OF THE TEST

The pinwheel

The means of presenting the required disparities is the most important element in any test for stereoscopic acuity. Its design must meet the following criteria:

1. disparities can be changed quickly (so as not to waste time),
2. disparities can be reproduced repeatedly without excessive variation (so that the results can be precise) and
3. the instrument can be calibrated (so as to establish the amount of each disparity).

When real metal rods are used to create disparities, as in Howard's experiment, the first criterion is difficult to realize because both rods must be displaced after each display. In order to follow Howard's example and at the same time to produce a compact and quickly executed test, a new way of presenting the rods had to be devised. This took the form of a flat metal disc to whose periphery were fastened a series of pairs of pins (the rods) whose separation in depth was arranged to give the disparities needed. Please refer to the sketch in Fig. 1. The disc and pin assembly (the pinwheel) was attached, by means of a hub, to the shaft of a stepper motor. The motor was mounted within a box whose front surface (a metal plate) was provided with an opening (a rectangular window) through which only the pair of pins at the top of the disc could be seen. The motor could step to any one of 24 equally spaced positions. Because each level of disparity was to include two examples (right pin nearer than left and left pin nearer than right) and one pair was to be of zero disparity (neither nearer), only 11 disparity levels could be presented. The principal levels were powers of 2 because 2 sec is the absolute limit of stereoscopic acuity and because this provides a sequence in which levels increase by a multiple of 2. Disparities were chosen so that at 60 cm the least was 4 and the greatest 512 sec. A distance of 60 cm was found to be the least for which the smallest disparities could be produced. Because the test was for clinical use, it was deemed unnecessary to provide an example of the absolute limit (2 sec). When scientific studies require the absolute threshold, the viewing distance can be increased to 1 meter at which the smallest disparity is 1.4 sec. Details of these and other dimensions are presented in Table 1 along with the

TABLE 1

Comparative dimensions of Howard's apparatus and Larson's at two distances

	Dimensions										
		Rod				Window				Disparity (at 60 mm interocular dist.)	
	Test Dist.	Gap		Diam		Width		Height		Smallest	Largest
Apparatus	(cm)	(cm)	(min)	(cm)	(min)	(cm)	(min)	(cm)	(min)	(sec)	(sec)
Howard's	600.0	6.0	34.4	1.0	5.7	20.0	114.6	12.0	68.8	1.7	116.7
Larson's	60.0	0.3	17.0	0.08	4.5	2.5	143.0	1.1	63.0	4.0	512.0
	100.0	0.3	10.2	0.08	2.7	2.5	85.8	1.1	37.8	1.4	184.3

same dimensions for Howard's original apparatus. At 60 cm, and in brackets 1 meter, the 11 disparities were as follows: 4 (1.4), 6 (2.2), 8 (2.9), 12 (4.3), 16 (5.8), 24 (8.6), 32 (11.5), 64 (23), 128 (46), 256 (92) and 512 sec. (184). In both cases, disparities were calculated for a person with an interocular separation of 60 mm. One pair of pins was of zero disparity. The upper limit of 512 sec was chosen because poor stereoscopic acuity is better evaluated by other tests and also because the monocular cue of diameter difference becomes available at about 200 sec.

The system

To be effective and of general use, tests for stereoscopic acuity must ensure that success cannot be obtained by any means other than depth perception through stereopsis. If a test is too simple, it can be memorised. If it does not include repetitions, success may be had by lucky guessing. A test is defeated if correct answers can be found by means other than stereopsis. The Titmus STEREO-TESTS which includes a 4 dot test is familiar to all optometrists and has all three of these defects. No optometrist, for example, can use this test on himself because he knows the answers already. The nearer of 4 dots is to be identified. Therefore the probability of success by guessing is 1 in 4. It has already been reported that monocular cues are made available by the eccentric position of the nearer dot[9]. The effectiveness of this test is therefore questionable.

The pinwheel was incorporated into a system which is shown in Fig. 2. The pinwheel and motor are within the box seen to the right, the patient's head is immobilized and positioned by the head rest and responses are obtained by two switches recessed in the table-top (the left one being visible in the figure). Seen on the table is a model used to demonstrate the test procedure. Not shown is the computer which runs the test nor the terminal which records the results. In other

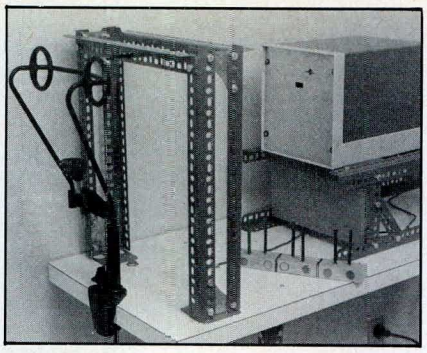

Fig. 2.
The test system. The head rest is to the left. The pinwheel is inside the box to the right. The small dark rectangle on the front face of the box is the window through which the pins are seen in silhouette against an illuminated background. Only the left push button can be seen. The metal bridge supports a refractor when needed. The demonstration model is seen on the table.

configurations, the computer may be contained within the pinwheel box and the terminal attached to its top surface.

All test procedures were programmed. Each program is a list of instructions which in its entirely describes fully and invariably a given test procedure. The results obtained with the system should therefore be free of operator errors. A number of different procedures have been programmed to emulate established tests and to create new ones. Any or all of these programs can be stored in the computer's permanent memory so as to be ready for immediate use.

The program

Programming details are beyond the scope of this description but certain of them are of special interest because they ensure that errors do not contaminate the data. The position of the pinwheel is checked after every measurement to ensure that the disparity seen was the one intended. A shutter closes the window as soon as the switch or switches have been actuated and remains closed until the disc is in the next position and has stopped vibrating. The shutter is always closed for the same time so that there is no clue to the amount by which the disparity has been changed. The time between the opening of the shutter and the actuation of the switches is recorded and if it is less than the typical reaction time the response is ignored and a message is displayed on the terminal to warn the operator that the person may be guessing.

Howard's original test procedure was programmed for use as a reference against which other procedures could be compared. This was found to be unsuitable for clinical use because it took too long to perform and was unreliable when stereopsis was abnormal. In it, the threshold of stereopsis was taken as the disparity at which the nearer rod was identified correctly in 75% of the presentations. This required 20 presentations to be made at each disparity otherwise calculations could not be made to within 5%.

A clinical test was devised and programmed in two versions; one for screening and the other for a detailed study. In the complete test, the approximate acuity was located quickly (starting from 64 sec) and then the threshold region was thoroughly investigated. Presentations at each disparity level were made in groups of three: left pin nearer (here identified as left), right pin nearer (right) and neither pin nearer (equal). The order of presentation was chosen at random so that the probability of success by guessing was 1 in 3 for each presentation. The probability of guessing all three presentations correctly was 1 in 27. In the detailed study, three repetitions of the group of three were made at a given disparity. The probability of success by guessing was thereby reduced to 1 in 19,683. When there was no penalty for answering "equal" incorrectly this probability was reduced to 1 in 729. If this were too low, the test could be repeated to give a probability of 1 in 531,441.

The test session

A typical test session began by entering the patient's (or subject's) name and interocular distance at the terminal. The person was then shown the two push button switches and how to use them to indicate relative positions of the pins. Push left button for left, right button for right

and both at the same time for equal. The head rest was adjusted to place the eyes at the same height as the window and to restrain the head from sideways movements (to obviate monocular parallax). If the patient were presbyoic, lenses were provided to ensure clear vision. This was done with a trial frame or else a phoropter head which replaced the head rest (it attached to the metal bridge shown in Fig. 2). Before the test began, zero disparity was displayed in the window. This ensured that the patient knew what equal looked like. The operator started the test from the terminal whereupon the window was closed for 2.4 sec. When it reopened, the patient indicated the nearer pin by means of the switches. The window then closed and reopened to reveal another pair of pins. This sequence was repeated until the test was either failed or the acuity found. In either case, the results were typed out at the terminal. The time required to perform the complete test was usually less than 3 minutes.

The results

Results have been presented variously depending on the test. Two examples are shown in Fig. 3 "Trial 1" is in the format of Howard's test with 20 repetitions at each disparity level. A reminder of this is given on the fourth line. Pin disparities are given in seconds and in brackets as the logarithm to the base 2. The 6th line shows the percentage of correct answers and which pin was nearer when the errors were made. As shown, 90% of the responses were correct (18/20) and both errors were made when the right pin was nearer. The average response time after the window opened is shown on line 7. This was slightly less (by 0.4 sec) when the left pin was nearer. An interpretation of these data is that the person had an excellent stereoscopic acuity (4 sec is the test's lower limit at 0.6 meters) and was able to detect the nearer pin quickly. Detecting the right pin nearer was the most difficult decision because both errors occured then. The "right" response time, being longer, confirms this.

Trial 1

Person "A" 's name

Date = 801209
P.D. = 64MM
Dist = 0.6M

Howard's Test, 20 repetitions

Disp. = 4 sec (2 $\log_2$sec)

90% Correct, errors: left 0, right 2

Response time: left = 1.2, right = 1.6 sec.

Trial 2

Person "B" 's name

Date = 810114
P.D. = 60MM
Dist = 1M

Disparity	- - - nearest pins - - -		
Sec ($\log_2$sec)	left	right	equal
4 (2)	3/3	3/3	3/3
3 (1.6)	1/2	0/2	1/2
2 (1)	1/2	0/2	1/2
Equal 10	2	0	8
Time (2)	3.7	2.0	2.7

Fig. 3.
Two examples of results as typed at the terminal. Left: Howard's test. Right: Complete clinical test. Refer to text for a complete description.

"Trial 2" shows the format for the complete clinical test. This was performed at a distance of 1 meter. The table presents the score at and below the perfect level (vide infra). The first column shows the disparity. The remaining columns show the score depending on which pin was nearest. The denominator of the fraction gives the number of presentations while the numerator gives the number of correct identifications. The perfect level is the least disparity at which all left and right identifications were made correctly; in this case 4 sec. The following lines show that only two presentations were made of each type. When the right pin was the nearer, no responses were correct (0/2). The equal line shows that "equal" was presented 10 times and that it was identified twice as left but never as right. The bottom line shows the average response time for each kind of presentation at the perfect level.

These examples show ways in which information can be compressed to assist in the interpration of the results.

DISCUSSION

This system used mechanical, electronic and computer technology to simplify and expedite stereoscopic acuity measurements. A clinician could learn to operate it in less than an hour. Patients have

TABLE 2

Stereo-acuity of 10 subjects by 5 methods

Subject no.	Stereo-acuity (sec of arc) Test A	Test B	Test C	Test D	Test E
1	4	11	85	20	60
2	8	7.2	39	20	120
3	12	15	55	20	30
4	12	18	140	20	30
5	12	36	210	20	240
6	16	3.6	65	20	30
7	16	7.2	140	20	120
8	24	3.6	140	20	30
9	24	40	440	20	120
10	64	3.6	140	20	30

found the test easy to comprehend and execute. So far, the youngest person to use it was 4 years old.

It has been demonstrated that performance cannot be improved by guessing. One person was confident that he could succeed, at least to some extent, using monocular vision alone. To make things easy for him, Howard's procedure was used (so that there would be two choices instead of three) and he was told that the nearer pin should look wider than the farther one. He failed the test at the 512 sec level with only 65% correct; a score which he might have equalled with his eyes shut. He had good stereoscopic acuity when tested binocularly.

As already mentioned, the same person can demonstrate different acuities when tested with different commercially available tests. Table 2 shows how the stereoscopic acuities of ten subjects differed when measured by 5 different tests; here identified by the letters A to E. Test A was the complete test decribed above. Test B and C were stereopairs, printed on paper backed with cardboard, viewed through a Brewster stereoscope. Both were by the same manufacturer. Test D was a random dot vectograph. Test E was a random dot red-green anaglyph printed on thick paper. Manufacturer's instructions were followed faithfully in each case. The results are arranged in order of stereoscopic acuity with respect to test A. It is seen that none of the other tests are in the same order. Test D is unique in attributing its best stereoscopic acuity to everyone. On the other hand, tests C and E often find very poor acuities. In tests A and B the range of numbers is similar but only 30% had similar acuities. Subject 10 showed the greatest dissimilarity which was 64 sec by test A and 3.6 sec by test B.

Which of these tests gave the best estimate of stereoscopic acuity? We suggest test A because it was performed without optical aids and used real objects whose disparity had been confirmed by calibration. It offered protection against guessing because the probability of success by chance was 1 in 729. On the other hand, the probability of success by chance in test D was at best only 1 in 4. We suggest these results substantiate our claim that this test sets a standard against which the performance of others can be judged.

Including zero (equal) among the disparity choices is not a usual practice. While it is of minor importance when testing persons with normal binocular vision it is an effective means for revealing anomalies of binocular perception.

The usefulness of zero disparity and of three possible responses is illustrated by a subject whose acuity was 2 sec with the automated version of Howard's test. We were surprised to find that he could do no better than 64 sec with the complete clinical test. Repeated measurements confirmed this. How could his stereoscopic acuity be 2 sec by one test and 64 sec by another? The subject provided the answer to this question himself. He explained that he could *always* tell when the left pin was nearer but at disparities of less than 64 sec he could *never* tell when right was nearer. In Howard's test, if left were not seen to be nearer he replied right and was always correct. When there were two alternatives, right and equal, this strategy was no longer successful. His stereopsis was evidently abnormal. Howard's procedure could not detect this but ours could.

Stereoscopic acuity is a threshold measurement which is customarily expressed in terms of probability; see Ogles discussion in Vol. 4 of Davson's The Eye.[10] This is appropriate for scientific studies but we are of the opinion that it is unsuitable for clinical use. Instead, we prefer to define stereoscopic acuity as the least disparity at which no errors are made. This is also a threshold because it is the least disparity beyond which the specified condition cannot be attained. To avoid confusion between this and the usual definition we have called it the perfect level.

For clinical purposes, stereoscopic acuity is the perfect level. When depth perception is required for a particular occupation this is so because mistakes will be made without it. The appropriate threshold is therefore the perfect level because the scientific definition includes the probability of errors. Most clinical tests for stereoscopic acuity identify this as the least disparity at which no error is made. Therefore, the perfect level has already been accepted as the clinical norm. Nevertheless, there is information to be gained by an examination of the failure mode below the perfect level. The "clinical procedure" provides for this by reporting results obtained at disparities of less than the perfect level and by showing how zero disparity was seen.

Acknowledgement

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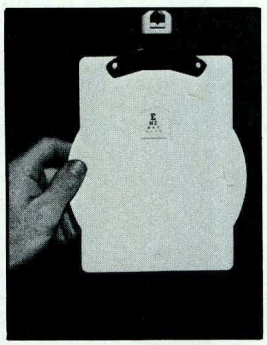

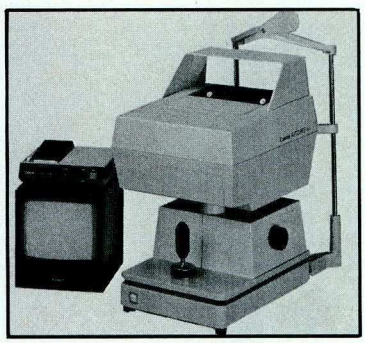

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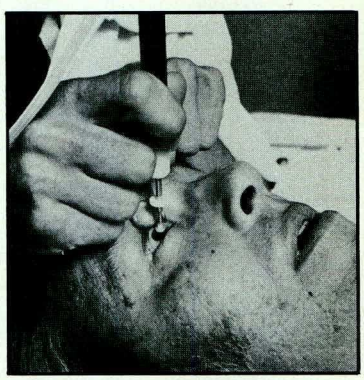

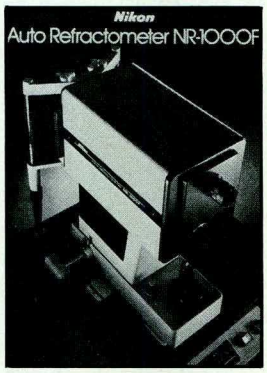

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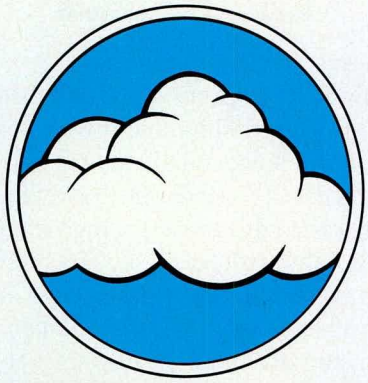

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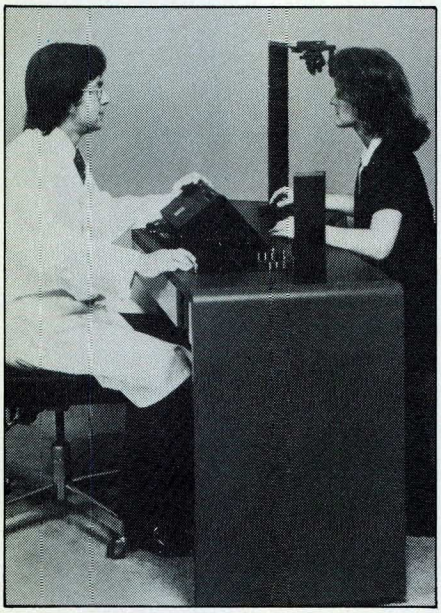

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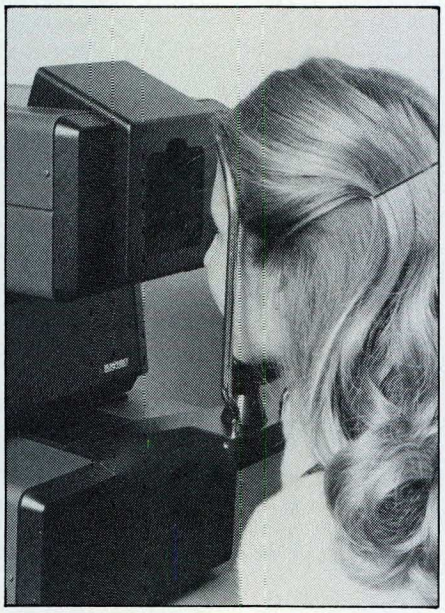

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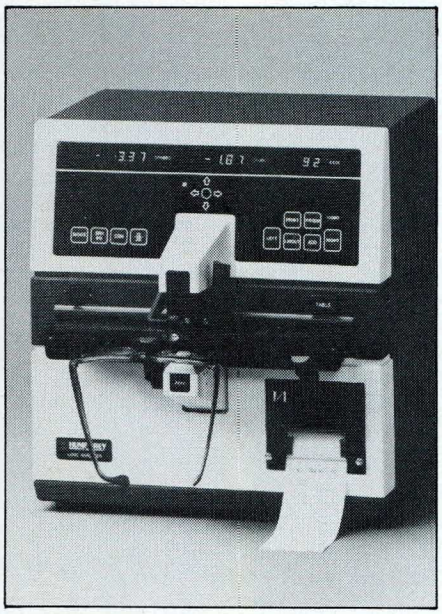

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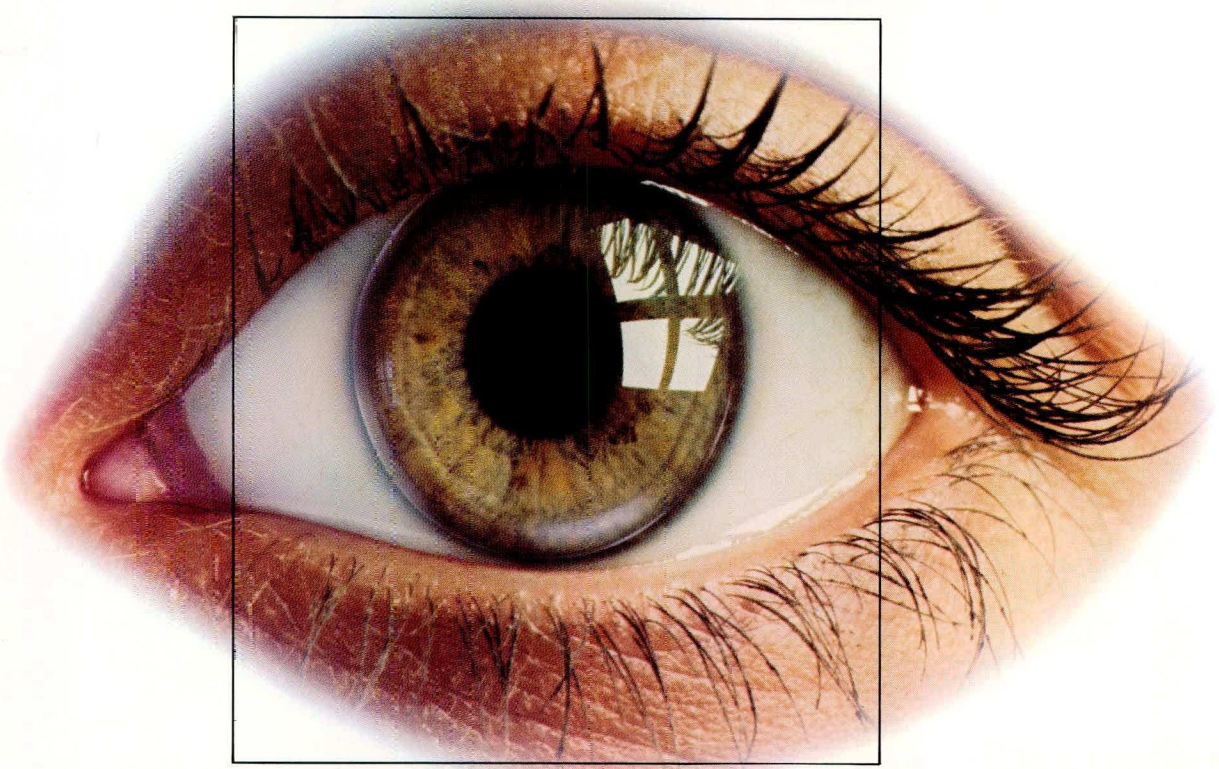

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