ISSN 0045-5075

THE CANADIAN JOURNAL OF Optometry

PERMANENT

LA REVUE CANADIENNE d'OPTOMÉTRIE

DECEMBER/DECEMBRE 1982

VOL. 44 NO. 4

384

What removes protein? Simply… Conveniently…Effectively.

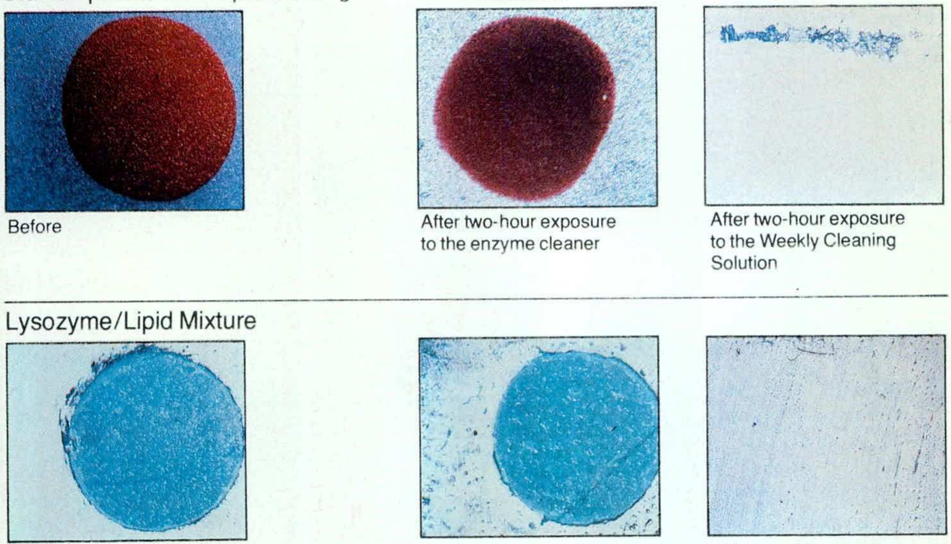
Barnes-Hind Weekly Cleaning Solution.

The premixed protein remover.

*Laboratory evidence.**

Before **After**

Stained protein with Lipid Coating — Enzyme Cleaner — Weekly Cleaning Solution



Before

After two-hour exposure to the enzyme cleaner

After two-hour exposure to the Weekly Cleaning Solution

Lysozyme/Lipid Mixture

Before

After two-hour exposure to the enzyme cleaner

After two-hour exposure to the Weekly Cleaning Solution

"Weekly Cleaning Solution effectively removed protein."

Evidence is clear! Barnes-Hind Soft Lens Weekly Cleaning Solution removes protein... effectively, without mixing, odour or fuss. It is a *premixed* protein remover solution that helps keep lenses crystal clear.

Unlike the enzyme tablets, which do not clean by themselves, Weekly Cleaning Solution needs no extras. The tablets, used as directed, require distilled water, plus a surfactant cleaner before and after use. Weekly Cleaning Solution, on the other hand, works all by itself.

While enzyme tablets are not recommended for high water content lenses, Barnes-Hind Weekly Cleaning Solution can be used safely with all extended wear, high water content lenses and can also be used effectively with gas permeable lenses.

Weekly Cleaning Solution contains a unique combination of surfactants that cleans away virtually all kinds of protein, including "bound" protein, even when covered with other lens soilants. In just 2 hours a week, it helps keep lenses clean as new. Patients can wear lenses longer, more comfortably, with good visual acuity.

Barnes-Hind Weekly Cleaning Solution ... the easy-to-use, effective premixed protein remover.

"A happy patient."

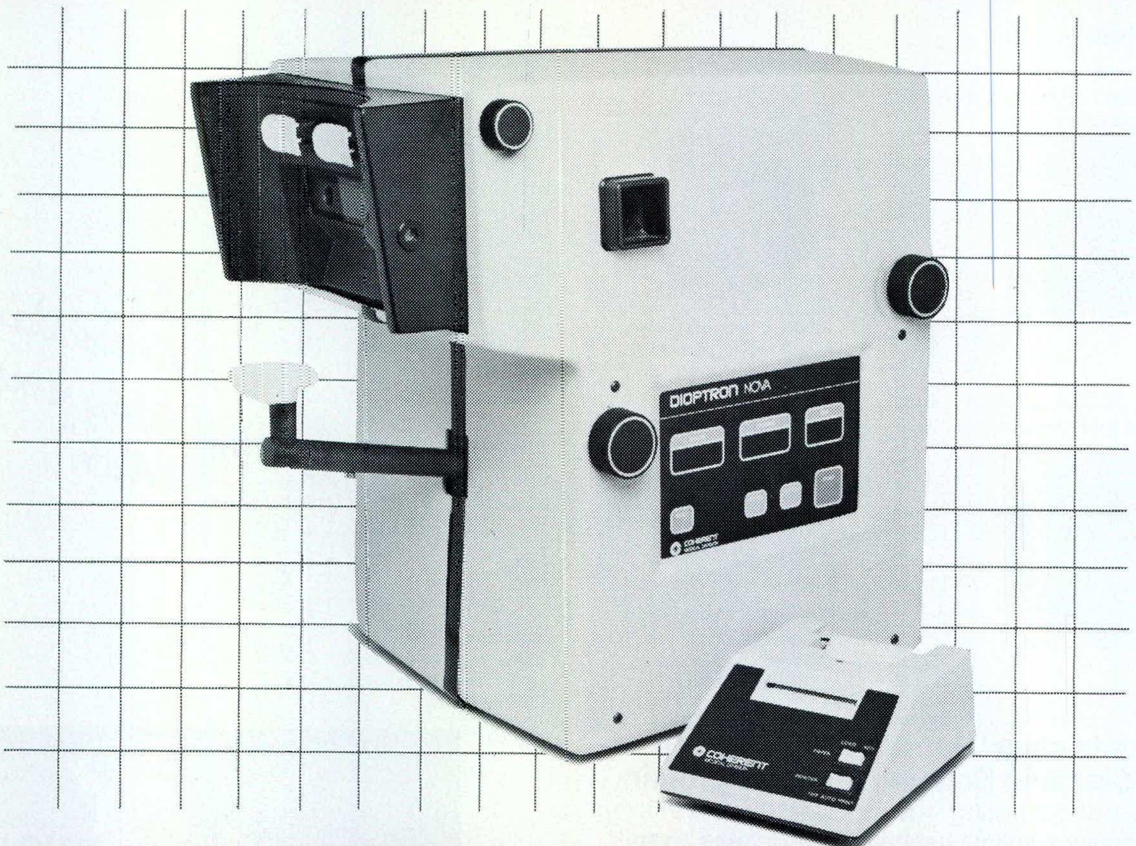
Premixed protein remover solution

BARNES-HIND®

BARNES-HIND CANADA
Mississauga, Ont. L5N 2M2

---

*Artificial debris deposited on slides, stained then subjected to cleaning. Data on file, Barnes-Hind Canada.



NEW

DIOPTRON NOVA
Objective Auto Refractor

Now, with Coherent's new Dioptron Nova from Imperial Optical Canada - you can effectively reduce your refraction-time to just a few minutes. With the rapid operation and unsurpassed accuracy of the new Dioptron Nova, even measurement on difficult cases will be made with less effort.

Versatility of functions and time economy are combined to allow increased patient traffic and maximum office flexibility.

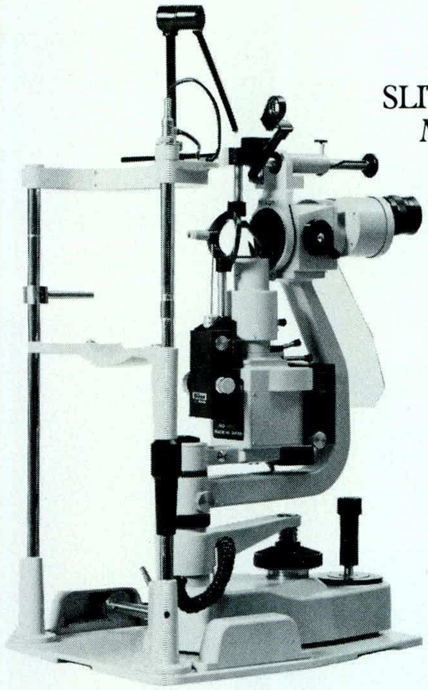
Contact your Imperial salesperson for more information or for an equipment trial in your practice.

IMPERIAL
OPTICAL
CANADA

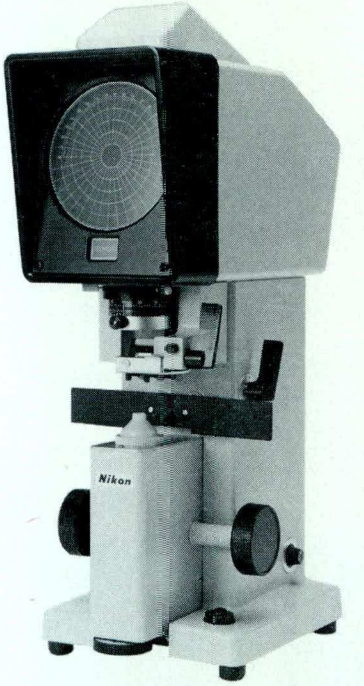
HEAD OFFICE: 21 DUNDAS SQUARE / TORONTO, ONTARIO M5B IB7
TELEPHONE [416] 595-1010 / TELEX 06-219691

SET YOUR SIGHTS ON NIKON!

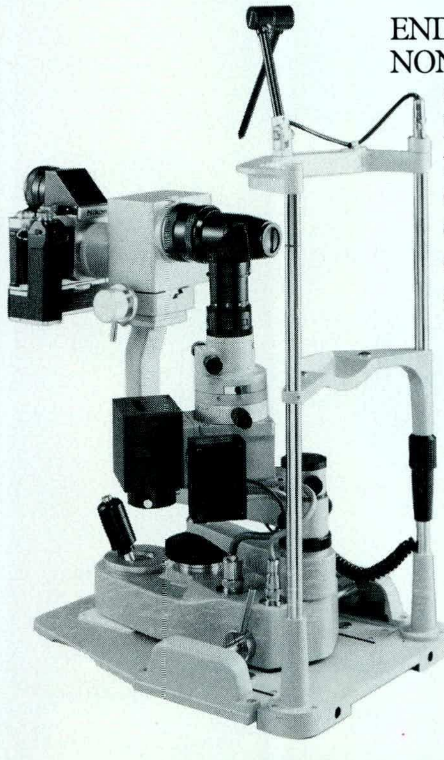
Nikon Ophthalmic Instruments, with their superior optical systems, design, and precision engineering, provide unparalleled optical performance and ease of operation. Set your sights on Nikon: for information on Nikon Ophthalmic Instruments, call or write us today.



SLIT LAMP
MICROSCOPE
MODEL CS-1
For general clinical use, an applanation tonometer is available

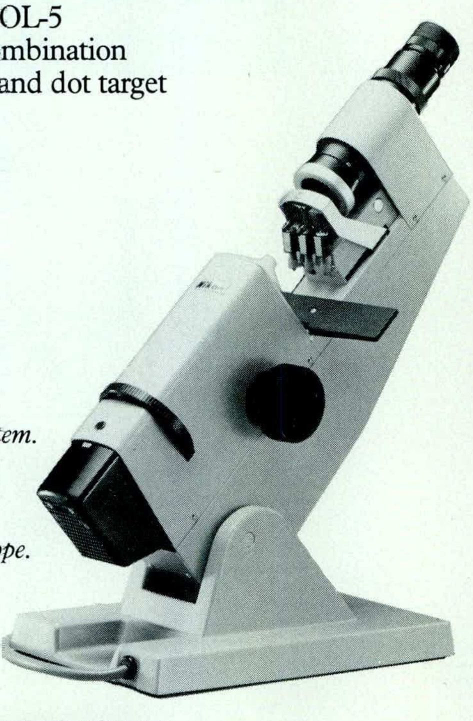


PROJECTION
VERTEXOMETER
For fast, accurate readings – ideal for contact lenses



ENDOTHELIAL
NON-CONTACT
CAMERA
For high resolution photography of the endothelial cell layer and other areas of the anterior-segment

OCULAR VERTEXOMETER
MODEL OL-5
With a combination crossline and dot target



Nikon also offers:

Zoom Photo Slit Lamp Microscope with Nikon 35 mm photographic system.

Aspherical Ophthalmoscopic Lenses.

Fundus Camera Retinapan 45-II.

Wide-30 Wide Angle Ophthalmoscope.

Nikon

THE IMAGE OF PERFECTION

Nikon Canada Inc., Instruments Division, 1366 Aerowood Drive, Mississauga, Ontario L4W 1C1. Telephone: (416) 625-9910. Telex: 06-960231.

NEW

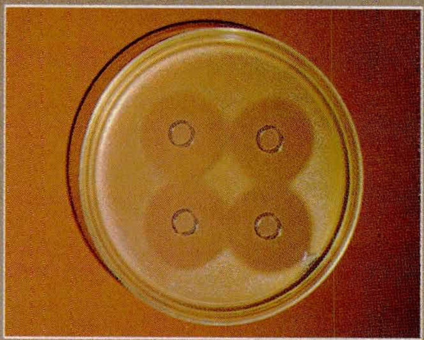
UniCare

ALL-IN-ONE SOLUTION FOR SOFT CONTACT LENS CARE

☑ CLEANING ☑ DISINFECTING ☑ RINSING ☑ STORING

UniCare Disinfects Effectively

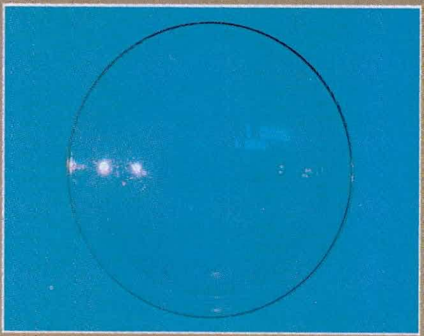
A culture of the bacteria staphylococcus aureus, one of the most common and serious causes of eye infection.



The same culture shown after the addition of a few drops of UniCare. The destruction of bacteria is apparent.

UniCare Cleans Effectively

A lens* contaminated with petroleum jelly.



The same lens after cleaning and rinsing with UniCare.

UniCare Is Safe In The Eye

An eye which exhibits clear signs of irritation.

The same eye after the application of UniCare is free of irritation.

UniCare provides a professional answer to the need for simplified lens care. It takes the confusion out of lens care and increases the probability of proper care. Safety with convenience is the promise of UniCare.

Available in 240 mL bottles

(lens case included)

*A hard lens has been used for photographic purposes.
Data on file re soft lenses.

ICN Canada Limited
Vision Care Division
1956 Bourdon Street
Montreal, Quebec, Canada H4M 1V1

THE CANADIAN JOURNAL OF OPTOMETRY

LA REVUE CANADIENNE D'OPTOMETRIE

Vol. 44 **OTTAWA, ONTARIO, DECEMBER 1982** **No. 4**

Editor —
G. Maurice Belanger, B.A., O.D., F.A.A.O.

Associate Editors
Joseph Mittelman, B.Sc., M.Sc., O.D., F.A.A.O.
Margaret desGroseilliers, O.D.
Joyce Barbour, O.D.
Business Manager
Michael J. DiCola, B.J., B.Ed.,

C.A.O. Bulletin Editor
Alex Saunders, B.J.

Business Office:
210 Gladstone,
Suite 2001,
Ottawa, Canada K2P 0Y6

In This Issue

C.O.C.L.S. Transactions:

Cover Photo by Malak. Color separations courtesy Wyman and Son Publications Ltd., publishers of Scenic Calendars of Canada.

Note: **Publication of advertising material in the Canadian Journal of Optometry in no way indicates endorsement of advertising content by the Journal or its publisher, the Canadian Association of Optometrists.**

THE CANADIAN JOURNAL OF OPTOMETRY is the official publication of the Canadian Association of Optometrists and is published quarterly. All original papers, clinical reports, books for review, proceedings of provincial Boards, Associations and Societies should be addressed to the Editor, Canadian Journal of Optometry, 210 Gladstone Ave., Ste. 2001, Ottawa, Ontario, K2P 0Y6. Subscription and advertising rates are available upon application. The Canadian Association of Optometrists and the publishers of this Journal have no objection to the reprinting by other magazines of any of the articles in this issue, provided such reprints are properly credited to the Canadian Journal of Optometry. Reproductions of articles by other than professional journals with permission of editor only.

Rates $5.00 per Copy $20.00 per year
Postage paid in cash at third class rates, permit number 3019. Return postage guaranteed.
Typesetting, Layout & Printing: Love Printing Service Ltd.

MAKE A MOVE IN THE RIGHT DIRECTION.

AQUAFLEX®

Here's a winning strategy for your contact lens practice...offer your patients the excellent centration and outstanding visual acuity of a full range of Aquaflex (tetrafilcon A) lenses.

Aquaflex offers a complete range of soft contact lenses that include Standard Minus 13.0 diameter and 14.0 diameter, Superthin Minus and Superthin Low Plus, Aphakic (High Plus) lenses. Complete inventories are carried not only in Toronto but also Calgary, Winnipeg, Montreal and Fredericton. Whether you fit from diagnostic sets or from inventory, there is an Aquaflex purchase plan tailored to the size of your practice.

The next move is yours...take the initiative and call us toll-free:

Nationally	1-800-268-6573
B.C., Alta.	1-800-661-1121
Atlantic Canada	1-800-561-0032
Quebec	1-800-361-0739
Manitoba, Sask.	1-800-665-8938

AQUAFLEX®
Contact Lens Products
UNION OPTICS CORP. (CANADA) LTD.,
2 PRINCIPAL ROAD, SCARBOROUGH,
ONTARIO M1R 4Z3

EDITORIAL

Market Research

Every so often a survey form crosses my desk from some market research agency along with an invitation to supply specific data from my office files.

These surveys request a comprehensive practice profile including my services and merchandise, as well those optical supply companies, be they contact lens people, instrument makers and frame manufacturers that I choose to deal with.

At no time have such marketing agencies ever informed me as a practitioner and consumer as to whose interests are actually represented or promoted by the circulation of these surveys. Nor have any of the optical companies ever chosen to notify me or my colleagues that they have retained the services of XYZ Market Research Agency.

To my mind, if I were to receive a single letter from one firm only, this would not be sufficient to motivate me to reply in any case.

Let me explain. For example, the most recent of these surveys to land on my desk listed only five large firms. What happened to all of the other medium size and small firms in operation? If such surveys are to be useful and unbiased they should not be restrictive. Indeed, they should list all legitimate optical supply firms. It is for this reason that I challenge the wisdom of cooperating with these anonymous surveys. The participant has no way of determining whether the survey jointly serves the interests of one or more of the firms listed or if some unlisted competitor seeks to enhance his own data base at the expense of others.

Furthermore, this practitioner, for one, finds the offer of an insignificant premium labelled "honorarium" upon completion of a questionnaire, to be somewhat insulting. Seriously, who is going to respond when retrieval of such data means accessing oneself to 5 - 10 years of pertinent data.

If Market Research people sincerely desire the cooperation of their 'target population' they might at least be open about the sponsors and the purpose for which the research is intended.

Such is the attitude of this writer and, if I am not mistaken, one which is shared by many colleagues.

G.M.B.

Congratulations to School of Optometry University of Waterloo 1982 Graduates

Doctor of Optometry

Edward Azzola	Sudbury, Ontario
Irene Bardecki	Bond Head, Ontario
Brian Barry	North Bay, Ontario
Roland Bauder	Calgary, Alberta
Darcy Bauer	Rocky Mountain House, Alberta
Paul Bihun	St. Catharines, Ontario
Charles Booth	North Bay, Ontario
Ken Carlson	Red Deer, Alberta
K.L. Catherine Cheung	North Bay, Ontario
Barbara Slatcher Crossley	Bracebridge, Ontario
Todd Dakers	St. Catharines, Ontario
Paul Dame	Calgary, Alberta
James Dippel	Kitchener, Ontario
Laurie Dodds	Edmonton, Alberta
Brad Elgie	Sault Ste. Marie, Ontario
James Evans	Regina, Saskatchewan
Douglas Fernick	Grimsby, Ontario
Timothy Hennig	Waterloo, Ontario
Millard Hoover	Scarborough, Ontario
Douglas Jenkins	Pasadena, Newfoundland
Betty Van Ymeren Johnson	Aylmer, Ontario
Len Jozwik	Toronto, Ontario
Wayne Klettke	Calgary, Alberta
Linda Kwasnick	New Hamburg, Ontario
Richard Liszak	St. Catharines, Ontario
Lorelei Locker	Nipigon, Ontario
Vicki Lum	Richmond, British Columbia
Arthur Marchand	Kitchener, Ontario
Allan McCabe	Dresden, Ontario
David McKenna	Cardigan, Prince Edward Island
Catherine McManuis	St. John, New Brunswick
Joseph Militello	Toronto, Ontario
Brent Morrison	Baden, Ontario
Lyle Myrfield	Port Alberni, British Columbia
Janis Newell	Kapuskasing, Ontario
Vernon Prentice	Renfrew, Ontario
Brian Price	Gananoque, Ontario
Harry Prizant	Montreal, Quebec
Jawahar Rawal	Willowdale, Ontario
Karin Rummell	Scarborough, Ontario
Mario Santos	Toronto, Ontario
Hans Schuster	Winona, Ontario
Gordon Searles	Sault Ste. Marie, Ontario
James Sills	Renfrew, Ontario
Karen B. Smith	Toronto, Ontario
Karen M. Smith	Mississauga, Ontario
Shelley Sorgini	Sudbury, Ontario
Marlee Spafford	Don Mills, Ontario
Victor Spear	Toronto, Ontario
John Stewart	Moncton, New Brunswick
Ralph Teeple	Arkona, Ontario
Robert Town	Orillia, Ontario
William Tucker	Kitchener, Ontario
Susan Vertefeuille	Regina, Saskatchewan
Ann Marie Volk	Regina, Saskatchewan
Donald Waters	Sarnia, Ontario
John Wessel	Regina, Saskatchewan
Robert Wilson	Saskatoon, Saskatchewan
May Wu	Vancouver, British Columbia

M.Sc. Physiological Optics

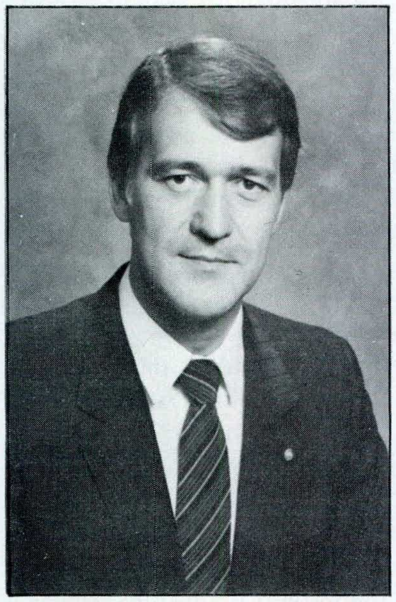
William Bobier	Kitchener, Ontario
B. Ralph Chou	Toronto, Ontario
Carol Dalziel Phillips	Waterloo, Ontario

Dr. Roland des Groseilliers New C.A.O. President

C.A.O. Council has elected Dr. Roland des Groseilliers of Ottawa as national Association President for the coming term. Also elected at the October 16, 17, 18 Council meeting as President-elect was Dr. Ralph Rosere, Dartmouth, Nova Scotia and, as Treasurer, Dr. Bruce Rosner, Winnipeg, Manitoba.

Dr. Reid MacDuff will continue to serve in an executive capacity as C.A.O. Past-President, while the province of Newfoundland will still be represented by his alternate, Dr. Jim Patriquin of Cornerbrook.

At its Fall meeting, Council also honoured departing Past-President Dr. Hervé Landry, Moncton, New Brunswick, who has completed a decade of elected service to the Maritime province and to C.A.O. in his capacity as Councillor and President. Councillor for the province of New Brunswick will now be Dr. Robert Bell, of Moncton.



Dr. Roland des Groseilliers, C.A.O. President

Completing the C.A.O. Council under President des Groseilliers are Dr. Rix Graham, Prince George, B.C.; Dr. Scott Brisbin, Edmonton, Alta.; Dr. Jim Krueger, Saskatoon, Sask.; Dr. Barry Winter, Weston, Ont., who will serve as alternate delegate for Ontario during Dr. des Groseilliers' executive term; Dr. Paul Lambert, Quebec City, P.Q. and Dr. Rainer Zenner, O'Leary, P.E.I. Mr. Don Scheafer of Ottawa will continue to serve Council as Executive Director of C.A.O.

Dr. Roland des Groseilliers has been a C.A.O. Councillor since 1975, coming to the position following his term as President of the Ontario Association of Optometrists. Active in the community as well, Dr. des Groseilliers is a past President of the South Ottawa Rotary. He and his wife, Margaret, also an Ottawa optometrist sharing his practice, have three children, Danielle, 10, Manon, 9 and Jennifer, 9.

Seated l - r: Dr. Bruce Rosner, Treasurer; Dr. Ralph Rosere, President-elect; Dr. Roland des Groseilliers, President; Dr. Reid MacDuff, Past-President.
Standing l - r: Dr. Jim Krueger, Sask.; Dr. Rainer Zenner, P.E.I.; Dr. Rix Graham, B.C.; Dr. Jim Patriquin, Nfld.; Dr. Paul Lambert, P.Q.; Dr. Scott Brisbin, Alta.; Dr. Barry Winter, Ont.; Mr. Don Schaefer, C.A.O.

Profiles in History:
Nova Scotia Association Honours Dr. John Mulrooney

N.S.O.A. President, Dr. Ron Haines (l.) presents painting to Dr. John Mulrooney.

Mrs. Georgina Haines (l.) presents roses to Mrs. Stevie Mulrooney.

"In the field of optometry in Nova Scotia, one man stands out above others. His life is one we would do well to emulate."

With these words, Dr. Ron Haines, President of the Nova Scotia Association of Optometrists opened the tribute to Dr. John Mulrooney of Chester, held at the Nova Scotian Hotel in Halifax on November 6, 1982.

At the banquet, Dr. Mulrooney received the association's first Eminent Service Award in the form of a painting by Dartmouth artist Wayne Lovett. Dr. Haines described Dr. Mulrooney's long service to the provincial and national association.

"He was a pioneer, a real doer in our association — a latter day father, or perhaps I should say, a godfather, always willing to help others," said Dr. Haines.

Born in 1916, Dr. Mulrooney graduated from the Ontario College of Optometry in 1935. He served as Secretary Treasurer of the Board of Examiners from 1940 to 1961, and as the association's Secretary Treasurer from 1961 to 1973. He became provincial representative to CAO in 1947, becoming Vice-President in 1951, and President in the following year. He served as Treasurer of CAO from 1955 to 1963. When CAO instituted the President's Award in 1965, the unanimous choice for the first recipient was John Mulrooney.

Dr. Harold Coape-Arnold, John's classmate at COO wrote;

> "It was a herculean task to keep the association in the black and to lay the foundations which permitted the association to survive despite very limited funding. John's greatest trait was an ability to get along with other people, to smooth troubled waters, and to prevent mavericks like myself, Don Francis and Manny Finkleman from going overboard, . . . Don, Manny and I served as Presidents after John, and it could be said that he educated us in the presidency."

In presenting the Eminent Service Award, Dr. Haines stated that it was a "token of our respect and appreciation." Then Dr. Don MacArthur read greetings from some of John's many friends. Mayor Ron Wallace, a member of the association, was unable to attend the meeting because of illness. He sent a letter of appreciation, a book, and a Special Certificate from the City of Halifax, recognizing Dr. Mulrooney's outstanding community service. Dr. Ralph Rosere read greetings from the immediate Past-President of CAO, Dr. Reid MacDuff, commending Dr. Mulrooney on serving the profession and his patients, and a message from CAO President Dr. Roland des Groseilliers expressing appreciation for John's "many years of dedication." Dr. Rosere added; "When I became Secretary-Treasurer, John's advice was always there when I needed it."

In responding, Dr. Mulrooney, in his smiling, modest way, expressed his amazement at hearing what he'd accomplished.

"We had a terrific association, and a terrific group of fellows," he said, referring to the early days of both the provincial and national associations. "We had to learn what we wanted and how to get it. We knew we had to professionalize or die."

He recalled "our MSI days, and the sincere, hardworking group that brought optometry under it in 1973." Expressing his happiness at seeing his old friends and so many new members, he ended his short speech by stating that "any benefits I got came from the efforts of others."

In presenting flowers to Mrs. Stevie Mulrooney, Mrs. Georgina Haines touched on another dimension of John's life, speaking simply and from the heart. She spoke of Stevie's "humility and pride", and of her role as co-worker and inspiration to John. She listed the number of tasks that Stevie had undertaken in helping John to advance the profession and the association, and spoke of her "special charm that has inspired us all." Then she presented the flowers with "deep gratitude and love."

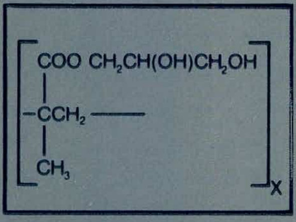
Words cannot capture the feeling of warmth and affection that suffused this event. During the day, Dr. G. N. Getman, an optometrist who is an authority of learning disabilities, had challenged younger members to meet people at their point of need. At a conference on learning disabilities in Halifax on the previous day, he said, key speakers had said; "If your kid's are having trouble in school — see an optometrist." He added; "Optometry is a profession that looks at people as individuals."

Dr. Mulrooney's career shows that optometric associations grow through the dedicated work of individuals who care for their peers and their patients. In honouring Dr. John Mulrooney, the Nova Scotia association recognized the leadership style of this remarkable man — that of getting ordinary people to do extraordinary things.

Jim Lotz, Executive Director
N.S.A.O.

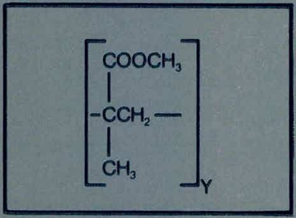
NOW AVAILABLE IN 14.8
AND A NEW 13.8 DIAMETER

SYNTEX
A NEW SOFT



$$\left[\begin{array}{l} COO\ CH_2CH(OH)CH_2OH \\ | \\ -CCH_2- \\ | \\ CH_3 \end{array}\right]_X$$

GLYCERYL METHACRYLATE (GMA)



$$\left[\begin{array}{l} COOCH_3 \\ | \\ -CCH_2- \\ | \\ CH_3 \end{array}\right]_Y$$

METHYL METHACRYLATE (MMA)

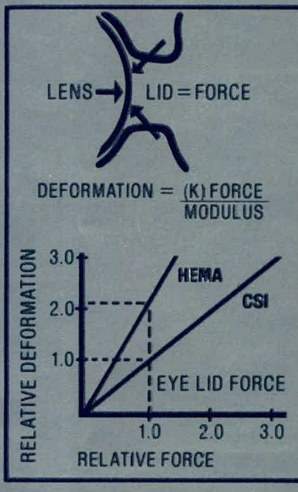
THE NEW CSI SOFT LENS

Glyceryl-Methyl Methacrylate, a new non-HEMA polymer from Syntex, gives the CSI soft lens improved performance in critical areas. Glyceryl Methacrylate (GMA) provides desired hydration, comfort and softness. Methyl Methacrylate (MMA) gives you many advantages of rigid lenses, making possible a thin soft lens of unusual optical stability. The new CSI lens offers improved vision, resistance to deposits and improved handling.

INTRODUCES LENS POLYMER

CSI™

(crofilcon A) SOFT CONTACT LENS



IMPROVED VISION AND HANDLING As the diagram and graph illustrate, CSI lenses deform less than HEMA lenses from eye lid forces. Less deformation with CSI results in a more stable optical surface and improved vision. Greater optical stability with CSI is due to higher polymer modulus, or stiffness, which also accounts for greater dimensional stability and superior handling.

RESISTANCE TO DEPOSITS HEMA lenses tend to accumulate deposits. Clinical studies with CSI soft lenses demonstrate a significant resistance to deposits. This can be attributed to CSI lenses having a smaller pore size than HEMA lenses (data on file at Syntex). FOR MORE INFORMATION, CALL TOLL-FREE 800-268-3964, IN TORONTO 821-7070.

SYNTEX

SYNTEX OPHTHALMICS, INC.
P.O. BOX 39600
PHOENIX, ARIZONA 85069-9982

IN CANADA:
SYNTEX, INC.
2100 SYNTEX COURT
MISSISSAUGA, ONTARIO L5M 2B3

Gradient-index Optics

W.N. Charman*

Abstract

The history of man-made devices involving the use of gradients of refractive index is briefly outlined and a typical component, the Wood lens, is described. Current methods for producing controlled gradients are reviewed, together with their limitations and applications. Some possibilities for using gradients to improve the design of spectacle and contact lenses are discussed.

Abrégé

Ce travail fait l'historique de différents appareils optiques utilisant un index de réfraction gradué et s'arrète sur un, soit, la lentille Wood. Les techniques modernes servant à la fabrication de ces "index gradués" sont décrites ainsi que leur applications et leurs limites. On traite de la possibilité d'utiliser des index gradués dans la fabrication de nouvelles lentilles ophtalmiques et de lentilles ce contacte.

Introduction

It has long been known that gradients of refractive index play a significant role in nature. In the atmosphere such gradients are responsible for mirages and similar effects. They also occur in the eyes of many species, notably in our own crystalline lenses.[1,2] Nearly a century ago, Exner[3] hypothesised that the functioning of many superposition and apposition compound eyes must depend upon the existence of suitable radial index gradients in the lens cylinder of each ommatidium, a proposal amply confirmed by later studies with interference microscopes[4].

The earliest theoretical study to suggest that inhomogeneous media potentially offer advantages in man-made devices was that of Maxwell[5], who found that any object point lying within a medium having a specified index gradient would be perfectly imaged at a single point within that medium. Only the last decade, however, has seen a real growth of interest in the field, well described in lengthy reviews by Marchand[6,7] and in a recent collection of papers in the journal Applied Optics[8]. The theoretical design possibilities are now being vigorously investigated and considerable progress has been made in devising suitable techniques for the production of the desired gradients. This review outlines the current position of this young technology and offers some speculations to indicate its potential in the optometric context.

The Wood Lens

As an introduction to the ideas of gradient-index optics, it will be helpful to compare the characteristics of a lens of uniform refractive index, n, with its possible gradient-index counterpart, the Wood lens[9].

One way of describing the effect of the thin, homogeneous, plano-convex lens in air, illustrated in fig 1a, is in terms of its action on an incident wavefront. Recalling that the time of passage of each local element of the wavefront through the lens is proportional to the corresponding optical path (ie. the product of the geometrical thickness and the refractive index), if the lens is to be convergent the optical path must decrease with distance from the axis in such a way that a plane, incident wavefront is converted to a spherical, convergent, transmitted wavefront.

Using the symbols of fig 1a and the small-angle, paraxial approximation, which implies that there is negligible change in incidence height on passing through the lens, and that $x \ll y \ll f^1$, the sag formula for the transmitted wavefront which has just emerged from the posterior pole of the lens gives

$$x = \frac{y^2}{2f^1}$$

where f^1, the radius of curvature of the transmitted wavefront, is the second focal length of the lens. As the

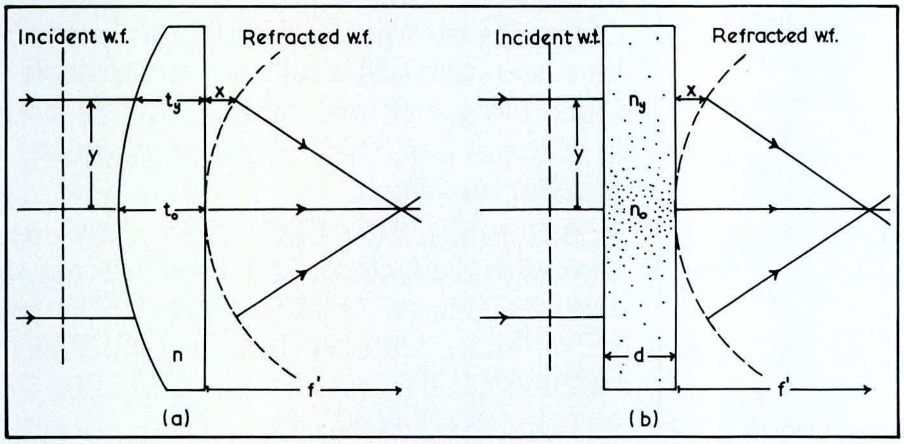


Fig 1 (a) The effect of a homogeneous plano-convex lens on a plane incident wavefront.
(b) The effect of a Wood lens, having a radial or cylindrical gradient of refractive index, on a plane incident wavefront. Stippling represents the region of higher index. In both cases the relative thickness of the lens has been greatly exaggerated for clarity.

---

*Department of Ophthalmic Optics, UMIST, PO Box 88, Sackville Street, Manchester M60 1QD, UK.

optical paths between corresponding portions of the incident wavefront tangential to the anterior pole of the lens and the emergent wavefront must be equal

$$nt_O = nt_y + (1.0).[(t_O - t_y) + x]$$

where the refractive index of the air is 1.0.

$$\text{or } t_O - t_y = \frac{x}{n-1} = \frac{y^2}{2f^1(n-1)} \quad \ldots\ldots \text{(i)}$$

Equation (i) shows that the thickness of the lens must decrease in parabolic fashion with distance from the axis. It is, of course, a form of the sag formula for the anterior surface of the lens, implying, not surprisingly, that this surface must be spherical with radius, r, given by

$$r = f^1(n-1).$$

Consider now the lens shown in fig 1b. This has constant thickness, d, but a radial, or cylindrical, gradient of refractive index such that the index, n_y, changes systematically with distance, y, from the lens axis; the iso-index surfaces are thus cylindrical. Such a lens is now usually called a Wood lens, after its originator[9]. Again, if the emergent wavefront is to be spherical with radius f^1, we have

$$x = \frac{y^2}{2f^1}$$

Further, the requirement that the optical paths between corresponding points on the incident and emergent wavefronts be equal implies, if n_O is the index on the lens axis,

$$n_O d = n_y d + (1.0).x$$

$$\text{whence} \quad n_O - n_y = \frac{y^2}{2df^1} \quad \ldots\ldots\text{(ii)}$$

Comparison of equations (i) and (ii) shows that the parabolic thickness variation of the homogeneous lens has been replaced by a parabolic index variation in the constant-thickness, gradient-index case. This is again a paraxial approximation, more refined derivations being given by Wood[9] and Fletcher et al[10].

Wood, using mixtures of glycerine and gelatine, was able to successfully demonstrate, at the beginning of this century, the imaging properties of lenses of this type. An index which decreases with distance from the axis gives a converging lens, while one that increases with distance gives a diverging lens.

Gradients Used and Related Devices

From the foregoing, it is obvious that the use of an index gradient allows the optical path to be varied independently of the geometrical thickness. It thus offers a whole new degree of freedom to the optical designer. In principle, any three-dimensional variation in index can be conceived but practical constraints have so far led designers to concentrate on three basic types of gradient - axial, radial or cylindrical, and spherical (fig 2).

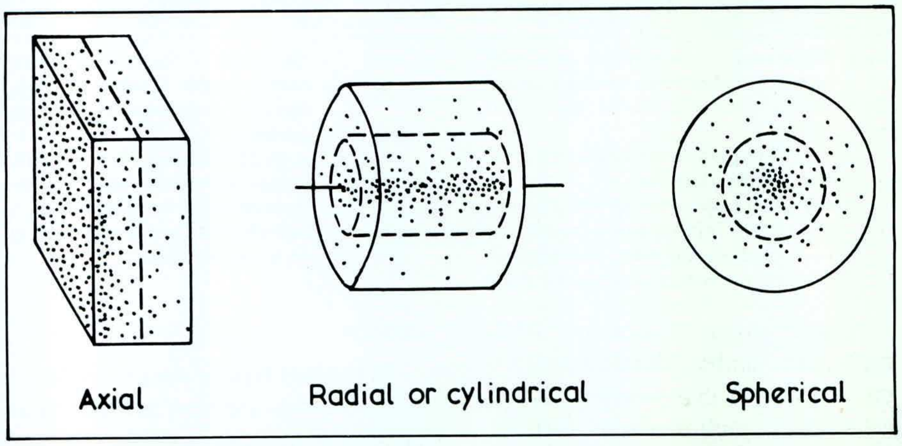


Fig 2 **Gradients used in most types of device that have been considered up to the present time. Stippling qualitatively represents the regions of higher index and the dashed lines show typical iso-index surfaces. Gradients of opposite sign are, of course, also possible.**

In the axial case, the iso-index surfaces are planes perpendicular to the optical axis. Sands[11] and Moore[12] have shown that there is a one-to-one correspondence between the use of an axial gradient and the use of an aspheric surface of revolution. Thus, a lens whose design in homogeneous index material requires an aspheric surface can be replaced by one with spherical surfaces and an appropriate axial gradient, with obvious simplification from the surfacing point of view. Moore[13,14] gives examples of the design of a singlet with two spherical surfaces, an axial gradient being used to control spherical aberration and coma.

Radial, or cylindrical, gradients have already been discussed in the context of the Wood lens. Marchand[7,15] has investigated the potential of Wood lenses with plane surfaces as photographic singlets and has calculated the corresponding aberrations. He finds that, providing the specified index profile can be made with sufficient accuracy, good control of aberration is possible. Further refinement can be achieved if spherical or aspherical surfaces are used in conjunction with the index gradient.[15] Other potential designs have been considered by Moore.[13,14] Some prototype lenses of this general type, possessing reasonable apertures, have been made at the University of Rochester.[16]

The biggest usage so far of radial gradients has been in the form of fibres for optical communication purposes, having diameters $\lesssim 100$ μm.[17] In such fibres, light is propogated in a series of S-shaped paths, never touching the fibre boundaries and propogation losses can be very low. Increasing use is also being made of GRIN (gradient index) rods.[18] These are typically several mm in diameter and normally have a parabolic index gradient which produces a series of inverted and erect, unit-magnification images down the length of the rod (fig 3). The length or 'pitch' of the rod, L, required to produce an image with unit positive magnification will vary with the parameters of the gradient. By cutting the rods to lengths L/4, L/2, L etc collimators, invertors or image relays can be produced. The action of these GRIN rods is, in fact, exactly the same as that proposed by Exner[3] for the lens cylinders of compound eyes.

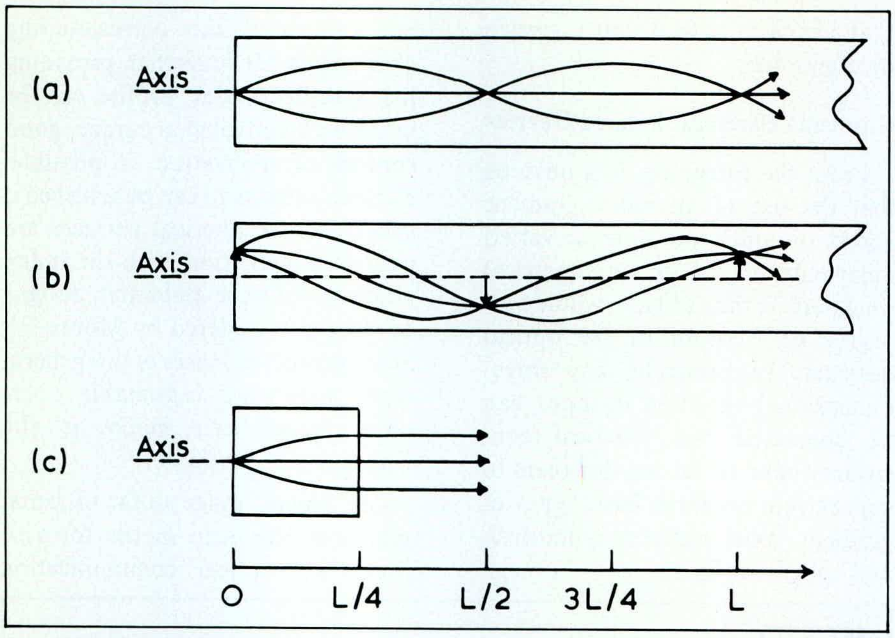


Fig 3 Meridional cross-sections of GRIN (gradient index) rods, having approximately parabolic radial index gradients.
(a) Ray paths from an on-axis point on the entry face.
(b) Ray paths from an off-axis entry point showing how a sequence of inverted and erect, unit-magnification images is produced down the length of the rod, repeating over a length L which depends upon the parameters of the index gradient.
(c) A quarter-pitch (L/4) GRIN rod, or lens, which collimates the light from any point on its entry face. A half-pitch (L/2) rod would act as an image invertor.

A wide range of uses for GRIN rods are under development[19,20], particularly as components in optical-fibre communication systems. One commercial photocopier already incorporates a GRIN-rod array to produce an erect unit-magnification image onto its copying drum[20,21]; again it is interesting to note that the optics of this system are closely analogous to those of the superposition compound eye. A further intriguing application, which may be of value in future ocular studies, is in the rigid 'needle scope'[18], designed particularly to allow examination of small internal regions of the body (fig 4). The GRIN rod, 0.75 mm in diameter, in the prototype instrument, is contained in a hollow needle. While the device lacks the flexibility of conventional fibrescopes, where the image is shared between a bundle of fibres, its small overall diameter gives it unique advantages, although problems remain to be solved as far as the image quality is concerned. There seems little doubt that GRIN-rods will be used in an increasing variety of instruments, including those intended for ophthalmic applications.

In the last type of simple gradient, the iso-index surfaces are spherical shells. While this was the earliest gradient to be considered, by Maxwell[3] and later by Luneberg[22], it has received little attention for optical purposes in recent years, although applications do exist in the field of microwave optics.

One rather separate application of index gradients involves their use as an anti-reflection treatment for optical surfaces, the overall extent of the gradients involved typically being only a few wavelengths. As the direction of these gradients is perpendicular to the surface being treated, they may be classified as axial or spherical, depending upon the surface geometry. As is well known, reflection at an interface between two optical media occurs because of the difference between the indices of refraction on either side of the boundary. This may, of course, be controlled by quarter-wavelength interference coatings but these require careful monitoring of film thickness and are not suitable for all substrates. Gradient index techniques reduce unwanted reflections by effectively replacing the abrupt discontinuity in refractive index at the boundary with a smooth gradation. Typically, then, the ideal gradient might involve a gradual increase in index from the air value of 1.0 to that of the bulk optical material (eg. 1.5). The extent to which the surface reflection is suppressed varies somewhat with the characteristics of the gradient[23,24] but reflectance at an air-glass interface can be reduced from ~ 4% to less than 0.1%.

Techniques for Manufacturing Gradients

The range of devices that can be achieved in practice depends crucially upon the manufacturer's ability to reproduce the gradients specified by the designer. In imaging devices very careful control of the gradients is necessary if image quality is not to be impaired; in gradient index fibres for communications purposes a wider tolerance on gradient quality can be allowed.

Table 1 (after Moore[16]) lists the

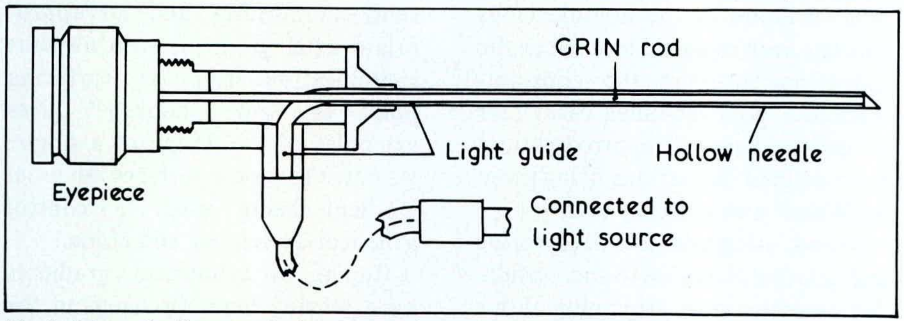


Fig 4 Schematic diagram of a 'needle scope' (after Uchida et al[18]), using a long GRIN rod contained in a hollow needle to relay an image to the eyepiece. The main problem with such devices at the present time is chromatic aberration and the difficulty in producing a uniform parabolic index gradient over the full length of the rod.

Method	Extent of gradient (mm)	Total index change
Neutron irradiation	0.1	0.02
Chemical vapour deposition	0.1	0.01
Ion exchange	10	0.04
Ion stuffing	50	0.04
Polymerisation techniques, etc.	100	0.03
Crystal growing	20	0.05
Anti-reflection treatments	0.001	0.50

Table 1: Methods for producing gradients of refractive index with approximate characteristics of resultant gradients (based on Moore[16]).

main techniques that have so far been devised. Their performance is specified in terms of two parameters: the overall depth of the zone of changing index and the overall change in the value of the index. It is immediately obvious that no method can yet produce large changes in index over reasonable distances.

In neutron irradiation, a boron-rich glass is bombarded with roughly-collimated thermal neutrons, the local neutron dose being controlled by a cadmium mask or attenuator of suitably varying thickness. In principle, the merit of this technique is that changes in the mask geometry allow a wide variety of gradients, typically a combination of axial and radial, to be achieved. Sinai[25] has demonstrated experimentally that the spherical aberration of a singlet can be corrected by the use of a neutron-induced index gradient; the index changes were found to be stable over periods of at least a few years. Nevertheless, only small index changes can be generated and it is difficult to see the method being used in a mass production context.

The chemical vapour deposition method, available in several variations[26], is widely used for the production of fibres with radial gradients. Typically, the starting material is a heated quartz tube, which is rotated about its axis. Through this tube are passed silicon chloride gas and oxygen, with controlled amounts of boron and germanium chloride vapours. Reaction occurs and concentric layers of doped glass build up on the inside of the tube, their refractive index being gradually changed by variation in the proportions of the reactants; the index of the deposited glass increases with the GeO_2 content. When the concentric deposits have accumulated to provide the desired, usually parabolic, index profile, the tube is further heated and collapses to a rod. This 'preform' can then be drawn out in a suitable furnace to produce the gradient-index fibre. Strictly, the production process tends to give a step-index profile, with, perhaps, 1000 layers. These steps become an effective continuum when the preform is drawn to fibre diameters but make the method inapplicable to the production of larger components.

The ion-exchange method, which closely resembles the chemical process for toughening glass, is probably the most popular of the current methods for producing larger components with index gradients. It relies on diffusion, the base glass being immersed in a high-temperature (~600°C) bath of molten salt for some hours. During this period, cations from the bath exchange one-to-one with alkali ions from the glass. The salt might be, for example, lithium bromide with sodium atoms in the glass being replaced. For so-called Selfoc lenses having a radial gradient, K+ ions from a potassium nitrate bath replace T1+ and Na+ ions from the original glass rod.[27] The gradient produced is usually approximately parabolic, although it is to some extent controllable through changes in such parameters as the materials used and the temperature and duration of the process. Too high a temperature may lead to a deformation of the glass. It may be possible to speed the production process by the application of external electric fields, this being known as field-assisted ion exchange.[28]

Ion stuffing is, as table 1 indicates, a promising technique in terms of the extent and index range of the gradients that it can produce but, as yet, it remains in its infancy. The process involves the use of a glass which phase-separates on heating. In one variation[20] an alkali-borosilicate rod is used, which separates into alkali-rich and silica-rich phases. The alkali-rich phase is dissolved out, using weak hydrochloric acid, to leave a pure porous silica skeleton. This is now soaked in an aqueous dopant solution containing suitable ions at an elevated temperature to raise the refractive index. After uniform 'stuffing' has been achieved, the concentration of dopant is modified by placing the rod in a weaker solution of dopant, when ions now diffuse out of the outer regions of the rod ('unstuffing') to give a lower index. When the desired index profile has been arrived at, the remaining dopant solution within the silica skeleton is crystallised by a sudden drop in the temperature. Subsequent reheating and consolidation thus yield a rod with a radial index profile. Modification of the geometry of the original host glass could presumably generate other forms of gradient. Advantages claimed for this technique include rapid profiling, the ability to use high concentrations of a variety of dopants to give different index changes, the possibility of producing large components and the durability and reproducibility of the gradients achieved.

Several methods for producing plastic gradient-index materials have been discussed in the literature.[7,16,20,29,30] Such methods include partial polymerisation of an organic monomer by controlled irradiation with UV or laser light, which potentially can produce large components with a wide range of index gradients,[16] and exchange-diffusion between different monomers,[20,29,30] this being reminiscent of the techniques employed with glass. While plastic materials may well be of great interest in the future, as yet they remain at the relatively early experimental stage.

Crystal-growing methods seem at present to be likely to be most useful for infra-red components where normal glasses lose their transparency. Typically, crystal-growing might involve starting with a seed crystal of sodium chloride and an aqueous solution of sodium and silver chlorides. As the crystal is slowly pulled from the bath, it initially grows by adding further sodium chloride, thereby decreasing the concentration of the latter in the bath and increasing the relative concentration of silver chloride. Further growth of the crystal necessitates it taking some silver chloride into its structure, this proportion gradually increasing with time to produce a gradual change in crystal index. Moore[16] believes that it will soon be possible to produce combinations of gradient-index silicon and germanium for infra-red components.

Techniques for producing gradients for the reduction of surface reflections form a specialised subgroup. Early methods, reviewed by Macleod[31], involved decreasing the surface index of glass by etching. Since that time, three variations have emerged. In the first[32], a chemical etch-leach process is applied to glasses sensitised by a phase-separating heat treatment. This produces a porous film which has very low density on the air side, the density steadily increasing towards the substrate. Such a film produces very little scattering providing that the pores are sufficiently small compared with the wavelength of light. A second alternative involves covering the surface with a regular array of conical nipples, spaced $\sim$200 nm apart. Naively, this produces a situation in which the fractional area presented to an incoming light beam by the higher index medium increases steadily from 0 to 100%: hence if the structure is small compared with the incident wavelength, the incoming beam sees a steady increase in effective refractive index. Remarkably, this means of reducing reflection was first hypothesised by Bernhard[33] as occurring on the corneas of nocturnal moths and the efficacy of a similar man-made nipple array, produced by a crossed system of interference fringes in photoresist, was demonstrated by Clapham and Hutley.[34] The last method, which bears some similarities to the nipple array, is applicable to plastic surfaces. It involves bombardment of the surface with high energy ions and subsequent etching of the particle tracks[24]. With a proper choice of parameters, the roughly conical etch pits overlap to produce a surface topography such that, on the wavelength of light, the material appears to have smoothly changing mass density and refractive index through the surface layer of a few wavelengths thickness. Both the ion-etch method and the nipple array have been demonstrated to achieve reflectances $< 0.1\%$, comparable with the best commercially-available, multilayer, interference coatings. While these techniques might have application to, for example, large or flexible components, particularly in solar energy technology, they are unlikely to be as robust as interference coatings and the latter therefore seem unlikely to be supplanted in the context of ophthalmic lenses.

To summarise, while chemical vapour deposition and ion-exchange techniques are now well-established methods for producing specific types of relatively small components, much remains to be done before any desired index gradient can be fabricated in any chosen size of component. Problems also remain in measuring the characteristics of the gradients achieved, although interferometric[35], prism[36], moiré[37] and other methods have been proposed; the chromatic variation of the index[38] is a particularly important parameter in many imaging applicators. However, great progress has been made in the last decade and it seems reasonable to expect that similar advances will be made in the future.

Ray-Tracing With Gradients

Clearly, the well-tried methods for tracing rays through homogeneous media, where the rays travel straight line paths from surface to surface, are inapplicable to gradient-index media, where such paths are in general curved. It becomes necessary to follow the ray along a series of short elemental paths and to describe its changes in direction by means of differential equations which can be derived from Fermat's principle.[7] Details of ray-tracing procedures are beyond the scope of this review but encouraging progress in developing methods suitable for computer programming has been described.[6,7,20]

Optometric Applications

It has been seen that, in principle, availability of index gradients presents the lens designer with a whole new degree of freedom. This might be particularly significant in optometry, where practical constraints normally limit the designer of single-vision lenses to permutations of only two surfaces and a single index and lens thickness, unlike the more fortunate camera-lens designer who can indulge in multi-element devices where many surfaces, lens separations, thicknesses and indeces allow better aberration control.

On the other hand, it is evident that limitations of the effectiveness and cost of present methods of producing gradients set constraints on the feasibility of many potential optometric applications that might come to mind. With the rapid advance of production techniques it is, however, well worthwhile to consider possible situations in which the lens gradients might be attractive.

Single-Vision Spectacle Lenses

As already noted, an axial gradient can be used to replace an aspheric surface of revolution.[11,12] Surfaces of the latter type have been used by several ophthalmic lens designers in recent years to produce lenses which are thinner or have superior cosmetic or optical properties. In general, however, aspheric surfaces cost more to produce than spherical surfaces. It may be, then, that useful improvements in overall lens characteristics could be achieved by adding an axial gradient to ophthalmic lenses with spherical surfaces. It might be possible to reduce costs by applying the gradient simultaneously to the front surfaces of large batches of lens blanks, perhaps by the ion-exchange process. If such gradients extended over a relatively short axial distance, they would be unaffected by any subsequent surfacing operations at the rear of the lenses.

Whitney[39] has outlined in a recent patent how a radial gradient might improve the optical performance of an ophthalmic lens of meniscus form; substantial improvements in performance over homogeneous lenses are claimed.

A further area in which it is tempting to consider the use of index gradients, in this case of the radial or cylindrical type, is for full-aperture high-powered ophthalmic lenses. When made in homogeneous material, such lenses inevitably possess high centre or edge thicknesses, with consequent disadvantages in weight and appearance; high-index glasses can reduce but not eliminate this problem. Could a Wood lens in either plano or curved form be superior to its homogeneous counterparts?

It will be recalled from equation (ii) that the power of the Wood lens is given by

$$F = \frac{1}{f^1} = \frac{2d}{y^2}(n_O - n_y) \quad .....(iii)$$

The constraints to the lenses that can be produced in practice are evidently set by the maximum extent and index change of the manufactured gradients (table 1). If we require some particular power F, thickness d, and diameter 2y, this implies that a specific value of (n_O - n_y) needs to be achieved. It can further be seen that the necessary value of (n_O - n_y) increases with the square of the lens diameter, unfortunately implying particular problems in the production of full-aperture lenses. Fig 5 illustrates this difficulty for the case where d has been assigned the relatively large value of 3mm. It is clear that production of lenses of reasonable power ($\gtrsim$6DS.) and aperture ($\gtrsim$50mm) requires substantial index changes ($\gtrsim$0.6). Table 1 emphasises that the latter are well beyond the capabilities of present processes which can only achieve maximum index differences of $\sim$0.04. Thus there is no immediate prospect of high-power, full-aperture, single-vision, Wood-type lenses becoming viable for optometric use.

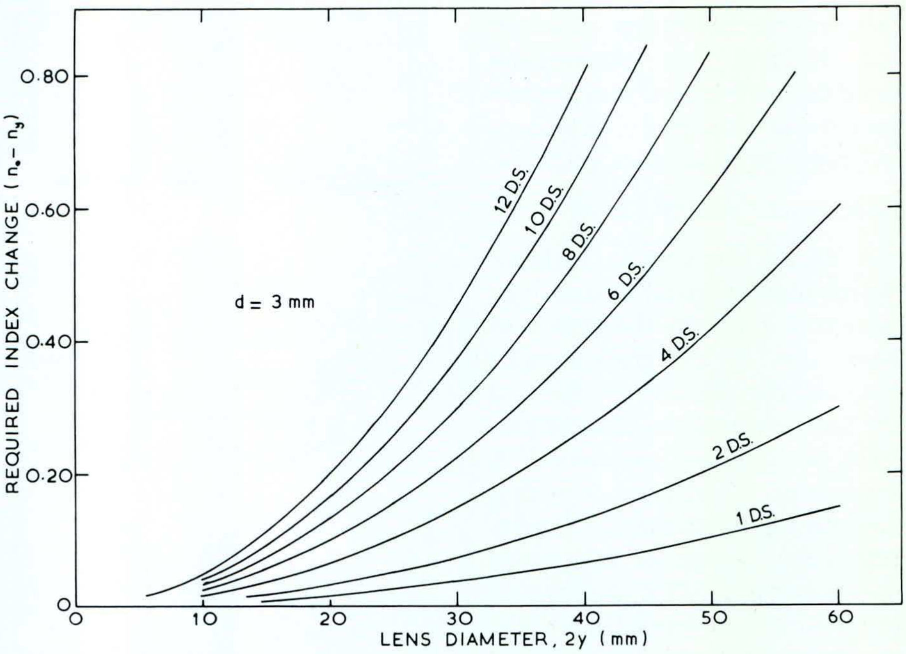


Fig 5 **Required change, n_O - n_y, in refractive index between axis and edge as a function of the diameter of a Wood lens for the spherical lens powers indicated. It is assumed that all the lenses have a uniform thickness of 3 mm.**

It is worth noting that further problems arise if thickness variation is introduced into a Wood lens. Thus, while it might naively be thought possible to grind a cylindrical correction onto one surface of the lens, the resultant thickness variation automatically introduces a variation in the power conferred by the radial gradient. The local power in any meridian becomes equal to the sum of the surface power, conferred by the curvature of the surfaces and the local index, and the Wood lens power, dependent on the index gradient and the local thickness.[40] If then, the latter varies, there is an associated variation in the correcting power of the lens over its surface.

In spite of these difficulties, Wood-type lenses of reduced aperture are very nearly feasible at the present time. An index difference n_O-n_y = 0.04 would allow an 8mm diameter lens of power 15D and thickness 3mm to be produced, while the diameter could increase to nearly 13mm if an index difference of 0.10 could be achieved. Thus 'invisible' gradient index lenticulars could be envisaged.

A small diameter, parabolic-index rod would be inserted into a concentric outer hollow cylinder of uniform material. The lenses could then be 'sliced off' from this rod, variation in thickness giving variation in spherical power. The lens could, of course, be in curved rather than in plano form, providing its thickness remains constant. The problem of incorporating a cylindrical prescription could be overcome by making the lens in 'two-layer' form, the gradient index element providing the anterior component with spherical power, while the rear element of constant index has a toroidal rear surface to correct ocular astigmatism and, possibly, to supplement the spherical power (fig

6a). Possible advantages in weight and thickness over conventional lenticulars are critically dependent upon the development of techniques for producing larger index gradients.

Bifocal and Varifocal Lenses

A bifocal lens with an 'invisible' Wood addition could evidently be fabricated in exactly the same two-layer form as the gradient-index lenticular (fig 6b), where in this case the homogeneous rear element provides the distance prescription. A 1mm thick Wood addition with a diameter of 10mm and an axis-to-edge index change of 0.04 would have power of 3.2 D.S., so that such lenses are almost within the range of current technology. Any potential advantage of such an invisible bifocal would have to be balanced against the cost and difficulty of producing it in comparison with existing types.

More interesting is the possibility of producing varifocal lenses, having a smooth gradation of power between the distance and reading portions, by gradient-index techniques. Recalling that the power of a lens can be attributed to the variations in optical thickness across its area, it is possible to envisage a lens of constant thickness where variations in local refractive index are used to produce any desired change in optical thickness. Thus the complex aspherics of such lenses as those of the Varilux or Unison type would be replaced by spherically-surfaced lenses with complex index variations.

Whether the required three-dimensional changes in index might be created in practice is debatable, but a concentric varifocal of the type illustrated in fig 6c could be constructed in the foreseeable future. The outer annular distance portion would be of uniform index and the central, circular region, constituting the reading portion to provide the appropriate addition, would be of the familiar Wood lens form, with a radial, parabolic index gradient. In the intermediate annular zone, the aim would be to achieve a smooth progression of power between the distance and reading portions of the lens. The required index gradient, which depends on terms of higher order than y^2, can be calculated in straightforward fashion.[41] Unfortunately, like the much earlier Beach 'blended bifocal'[42], where the required concentric variation in optical thickness was achieved by varying the geometrical thickness of a lens of uniform index, such a concentric varifocal suffers from unavoidable unwanted cylindrical power in the transition zone[43], which may limit its usefulness. It can be shown[41] that this unwanted cylindrical power is given by $y.dF_S/dy$, where y is the zonal radius and dF_S/dy is the radial gradient of sagittal power in the transition zone. Thus the problem becomes worse if the reading zone is made large, since this inevitably increases y in the transition zone.

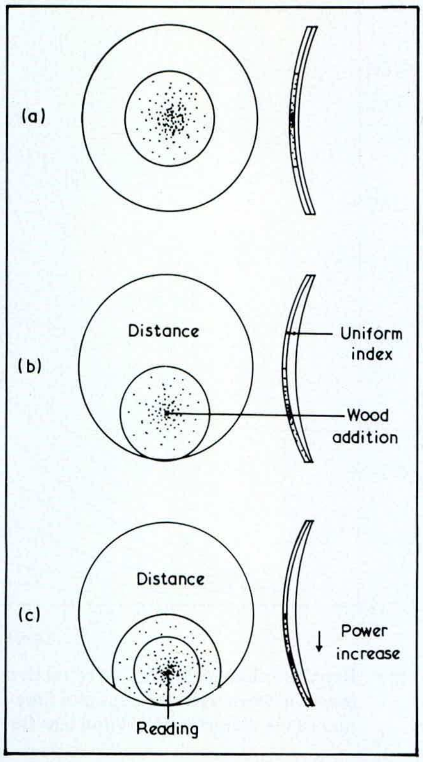


Fig 6 **Some hypothetical ophthalmic lens designs incorporating elements with radial refractive index gradients. In each case, the problem of correcting ocular astigmatism makes it necessary for the lens to be made in a two layer form, astigmatism being corrected by grinding an appropriate toroidal surface on the rear, homogeneous component. This would not be necessary for purely spherical corrections. Stippling represents regions of higher index.**

- **(a) An 'invisible' gradient-index lenticular. A near-afocal carrier of homogeneous index material supports the radial-gradient, Wood spherical correction.**
- **(b) An 'invisible' gradient-index bifocal. The distance prescription is in homogeneous material and the Wood lens provides the addition.**
- **(c) A concentric varifocal lens. The reading portion has a parabolic index gradient while the radial gradient in the intermediate zone is of a form to give a gradual blend of sagittal power between that of the reading and distance portions of the lens.[40,41]**

It should be noted that, in principle, any concentric variation in sagittal power can be achieved through the use of an appropriate radial gradient[41], although the feasibility of producing such gradients remains unproven.

Another possible design of varifocal using an index gradient and a carrier lens has been outlined in a patent.[44] Large changes in index (~ 0.14) were envisaged and no predictions were made of any associated aberrations.

Contact Lenses

There might well be fitting advantages in using a contact lens that had constant thickness across its area. Is this, then, a possible role for a gradient-index lens of the Wood type? Again we must consider the possible parameters. Taking a lens thickness $d = 0.1$ mm, a lens diameter $2y = 8$ mm and a nominal power $F = +5$D, we find that the required axis-to-edge index change for a Wood lens (equation ii) is 0.40. This is well beyond the scope of present technology (table 1). Moreover, if the lenses were cut from a single rod of constant radial gradient, each lens power would demand a different thickness of material, which seems undesirable. The alternative, of having a different parabolic, radial-gradient, stock rod for each power seems extravagant in terms of manufacturing demands.

At present, then, contact lenses in Wood form seem unlikely to be viable. It is possible that, if comparatively crude optical performance is acceptable, radial gradients could have a role in so-called variable focus bifocals, where the contact lens power changes progressively from the centre towards the periphery.

Profiles in History: An Interview with E.J. (Ted) Fisher

TF:

Before becoming personally involved in this interview, I would like to fill in some of the historical data pertaining to optometrical education and the original teaching institutions.

The Ontario Optometry Act in 1919 made it mandatory for the Board of Examiners to provide education facilities; in other words, the Board could not restrict the profession without providing for the training of newcomers to the profession. The Board started the school at the Central Technical High School. The course was a two-year option as part of the regular high school technical course — you graduated with a diploma in optometry. The instructors included some very famous names: Ivan Nott, George Keevil, Bill Fannon, J.C. Thompson (who taught physics and mathematics). This was J.C.'s first connection with Optometry. He had graduated from U. of T. with an M.A. in physics and went to Central Tech as a teacher. When the optometry program began, he was assigned to teach optics and physics to optometry students.

In 1925, the Department at Central closed for lack of funds, so the Board organized its own College. It started out as the College of Optometry of Canada, and there was an All-Canada Advisory Council, actually the forerunner to C.A.O.

I actually have a list of the people that were on that Council. There was a representative from Saskatchewan, one from Manitoba, from New Brunswick and Nova Scotia, and that was about it. They met in Toronto perhaps five times. Even back then there was talk of starting a Western School. (We have a letter on display at the moment in the museum, which says that they were trying to start the school in Winnipeg, being a central place in Canada.) You must remember that, in those days, even train travel was rather rugged, and if a person were going to come to a C.A.O. meeting (or an All-Canada Advisory Council meeting), it would take two days to reach Toronto from Winnipeg, three from Saskatchewan, about the same from New Brunswick and Nova Scotia. As a result, meetings were not very frequent because they kept you away from the office for up to six days of just travel, let alone anything else.

When the College started in Toronto in 1925, there was no Dean. An optometrist by the name of Wilkins was very prominent, one of the first teachers; and another, Ralph Aylesworth, from Trenton, was extremely active. He first approached Queens University and had serious discussions with Queens about starting the school there in the early 20's. It didn't materialize, but this was the first approach ever made to a university.

In the first year of the Toronto College's operation, they began scouting around for a Dean, and got hold of Thompson from Central Technical School. He started in September, 1926 and continued until he died, April 4, 1948. This was in the school's initial stages. The teachers were all part-time, with the exception of Thompson. (In the first year, they were *all* part-time, after that, Thompson became full-time). They had Bill Fannon, a teacher of mechanical optics, and Ed Bind. These people were paid so much an hour to come in and lecture. Part of the course was arranged through the University of Toronto; that concerned the basic science part of optics, biology, some physiology, some mathematics. (The early instructors in the university included a McTaggart in optics, Bailey in biology, and a lady by the name of Krueger in mathematics). We also had a course in law, taught by a chap named Grant, I believe. All these courses, which were mostly first-year subjects, came from the university. In addition, Thompson would give lectures each year in different subjects — applied optics and theoretical optometry. Bind would teach clinical work and pathology; and Fannon, the mechanical optics course. These were the early people.

The course itself was two years in length, with an admission requirement of Grade XII, until September, 1937 when it was increased to three years, with the admission requirement of Grade XIII. (This was also the first year I started teaching). The school at this time was also moved to 243 College Street on the 4th floor of the Ash Temple building. The clinic was greatly expanded as well. It was there from 1937 until 1945, when we moved back to 140 St. George Street, next door to the earlier building.

In 1948 (the year Thompson died), we had about 300 applications from veterans, and were able to take 120 of them. This had been made possible through an expansion in the U. of T. program, where they agreed to provide labs for optics, biology and other subjects. We rented the drill hall across the street, which had been used for Officer Training Courses, for our lecture work, and increased the number of part-time lecturers. Unfortunately, Thompson died before that first class of veterans graduated, but (Clair) Bobier was in that group. Irving Baker, Scarlatt Albright and others came in to assist. Bal Sparks, as well, was at the school from about 1937.

We also had to change our hours drastically. We had 7:30 a.m. lectures, and I had a few evening courses as well, in order to accommodate these large classes. It was at that time that I went into the school full-time (1945) and stayed from then on. I gave up practice entirely for a number of years until the big enrollment dropped. Then George Keevil died and his wife asked me to come in and help close the practice up — this would be about 1952 or 53. Well, I went in to close up the practice, and I saw this tremendous file of names. So I wondered what was going to happen to all these people. We couldn't get anyone to take it over, so I took it on as an evening and part-time practitioner.

CJO:

Going back to the post-war period, was there any concerted effort to draw the veterans to optometry?

TF:

No. They were given advice by vocational guidance counsellors. There was a shortage of optometrists at the time, and it was noticed. It's interesting, too, that a lot of our forebears came in after the First World War with some courses that W.G. Maybee taught, before there was a school of optometry.

CJO:

Bind was one of those.

TF:

He was. In the first place, he was English, but emigrated to Canada right after the First World War. He had been in eye work over there and that's how he got interested. Incidentally, his eye work had consisted of drawing fundus pictures, before the days of the fundus camera.

CJO:

What was the relationship of the College to the University of Toronto at that time?

TF:

It had always been that we paid a lump sum for whatever was offered, not on a basis of so much per course. I know that, when I was there, I had to sit down and negotiate it. One year, for example, it would be $15,000.00, another it would be $18,000.00.

Incidentally, we also got extra grants from the Federal Government at that time, because of the veterans. I think it was something on the order of $150.00 per veteran. The Board was very conservative in its salary scales, and it ended up we had to give the government back about $35,000.00 when all the accounting was done at the end. (It was over that

Central Technical High School, Toronto, locale for Department of Optometry, 1921-25.

issue that W.J. Dunlop resigned. He was Chairman of the Board at the time and was in favour of giving the money back. One or two of the Board members said, "Isn't there some way we could use this money? After all, we need it, and we have provided the service." Well, there was no way you could do it retroactively. If they had spent the money at the time, then no questions would have been asked, but they had to give this back. Dunlop was a little annoyed that it should even have been discussed and it was only about a month or two after that, that he tendered his resignation).

CJO:

Can you provide some clarification with respect to the College's dissassociation with the U. of T.?

TF:

What really happened was that we had had no difficulties in 1948, 49, 50. But about 1950, in the Fall, when Sydney Smith was President of the University, the Board of Governors decided that they were going to eliminate all extrinsic teaching. We were not the only ones — there were other ones which I can't recall, but there were other people taking courses on a contract basis. Well, Dr. Smith invited me to lunch at the York Club. I was only about 35, and he invited me to lunch at the York Club. He said that, because of the great expansion being planned for the university, the enrollment was going to grow and they had to divest themselves of all these external programs. It was sad news — I could understand it, but it was sad. He said there was no great pressure. "We'll give you at least two years to make arrangements to do what you can."

It was at that time that the Board ultimately decided to have a four-year program. It was felt we could work it if it was one year university and three years optometry. That way, we could require a lot of the basic science as admission status. The student would have to enrol for that at a university, take one year and then come to optometry. It turned out that enrollments were dropping and we felt that we lost a number of students that way. Those who took the first year university and were successful went on to take more, and optometry lost them. Our classes dwindled down to as few as six. The school couldn't carry on with the kind of income it had. After one year of experimenting with that, we went to a four-year professional program, which granted the O.D.

CJO:

You also had a part-time program leading to the O.D. Why was that set up?

TF:

It was felt that it wouldn't be fair to award the O.D. degree to new graduates, and not make it possible for any practitioner who wished to earn the same requirement without just assuming it. And so an updating course was offered for about five or six years. There were some 200 optometrists who took the updating course and earned the O.D. degree that way. The people teaching the course didn't take it, and if you look at the register, you'll notice we still have a few who have not got an O.D., including me. It was a good course, consisting of correspondence, with two weeks' required attendance each year, and an examination afterwards, which was arranged in the local community. The course also provided some financial assistance, but that wasn't the main aspect of it. If you only had six to ten students to teach, you had some spare time, so the faculty was put to work on writing these papers.

CJO:

So to bring the interview back to a personal level, how did you happen to come into optometry?

TF:

Well, you could say I fell into it. I think one has to realize the times, you see. We think we're having tough times these days, with the recession or some such thing. In 1929, there was a tremendous stock market crash, much worse than any year before or since. People who held stocks would jump off buildings; their savings were gone in five minutes and they just couldn't face it. There were people out of work. There were people wandering across this country. I don't think today's unemployment rate is very bad, compared to it. There was no unemployment insurance, there was no welfare. I was graduating from high school in 1932. What's a young fellow to do in that kind of a world? No jobs, and even experienced people were out of work. Carpenters, they could get for a dime a dozen, for example. It was a very, very difficult situation. In order to eat, you'd go out and dig ditches or do anything. That's if you could get some ditches to dig. Well, my father had a hardware store on Danforth Avenue. I worked there after hours when I was going to school and on Saturdays. I didn't like hardware — and hardware in those days was hard, hard work. They didn't have all the machinery they have today to cut and thread pipe, clean up window frames and put in stove pipe. None of that for me. So I was looking around for some sort of career. At the start of the summer, I hadn't known what I was going to do, but my mother and I decided to go back to Winnipeg for a trip (Dad stayed and watched the store). I was born in Winnipeg and my parents had lived there for many years, so we motored back. We got back to Toronto somewhere around the middle of August and I still had no career, nor had I even chosen one! I was just a high school graduate. Somebody at the time remarked that my cousin, Harry Cobean, had graduated in optometry about 1929 or 1930, and he had wonderful job opportunities. He had opened his own practice. (He had been offered $150.00 a week, which in those days was great big money, to go and work for somebody. But he had turned that down and started his own practice). So that looked like a good career — why didn't I get into this thing, Optometry? (It was new, remember. The school had only opened in 1925 and this was 1932 — seven years later). So I went down to see the Dean, and I can well remember the visit. Gladys Wallace was the secretary and the office was in the second ground floor room at 138 St. George Street. We used it as a library later. He was there and his desk was piled higher with papers than mine has ever been — it was just a heap! He interviewed me; I was accepted into the course and started two weeks later in optometry. They were small classes — I think there were about 18 started in our class, of which 16 graduated. So I just started, largely I guess, because of my cousin, at what seemed the only thing to do. I also had the choice of going into pharmacy; a friend of ours had a pharmacy at Pape and Gerrard in Toronto. I talked to my uncle, who said, "I wouldn't recommend it to you. We have to work nights, and I'm called out on occasion on Sundays and it's a perpetual job. People steal things out of the store and everything . . . ; you'll make a living, but . . ." So I decided. It was a very fortunate accident; I was the relative of an optometrist and that's what led me into it.

CJO:

So you had no conception of what optometry was?

TF:

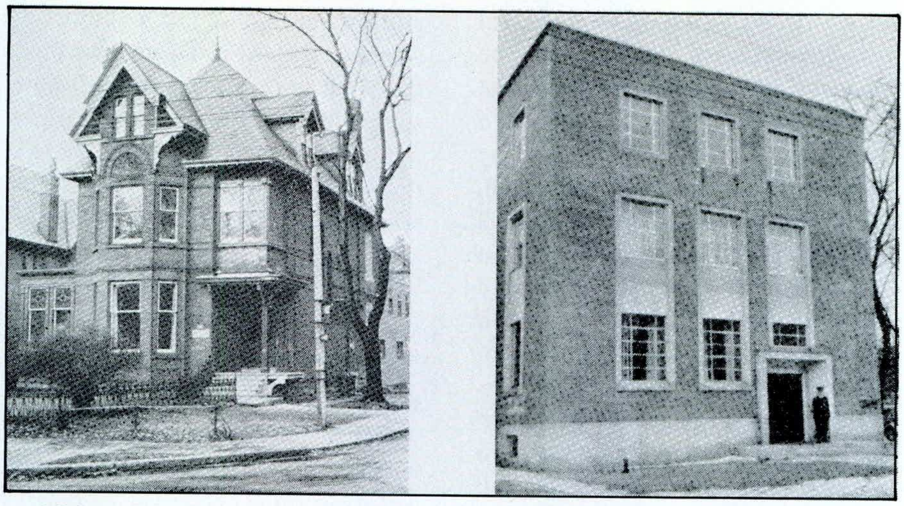
Very little. I knew it had something to do with eyes. George Bosnell had an office out near us, and it always looked very neat and tidy. He never did display glasses, and this was quite contrary to the run of the mill in those days. But he had a very professional office. I had no idea where optometry was going, or what it was going to do. I knew I had to pass the course; I knew I had to get a licence from the Board; and that's about it.

CJO:

Your impressions of the school building itself?

TF:

I honestly didn't think very much about it. It was in the university area, with some very fine homes around it of the same vintage. They were mostly fraternity houses, but I didn't know that. I was 18 and I don't think there was much emphasis on vocational guidance in those days.



140 St. George St., as it looked when it served as a Fraternity House, for Phi Theta Upsilon Fraternity 1938-45 and as the College prior to the building of the addition in 1953 to the front of the building.

CJO:

The question of campus status didn't have any influence?

TF:

We only used 138 St. George as headquarters, and we were around the university buildings a lot. We didn't officially have Hart House privileges but we went to Hart House just the same, for lunch and that kind of thing. We were a part of the university, but not really a part of it.

CJO:

Of course, you were living at home, then?

TF:

I was living at home. I had two dollars a week to pay for my carfare, lunches and I had some spending money. Five cents to buy a chocolate bar or something, you know. Those are old times. (This sounds like my father talking. He used to tell me that he worked for a dollar a day, and I couldn't believe it. Actually, to live on forty cents a day was simple).

CJO:

What about your recollections of Dean Thompson and his influences on you as a student?

TF:

J.C. was a great chap. He had very high moral standards and I think he instilled a lot of professionalism in us. I know our class took what was then called the Optometric Oath. I don't know if you've ever run across that, but it was very much like the Hippocratic Oath reworded for optometry . . . we would never use shoddy materials, we would give the patients the very best we could and everything of this nature. I think we had a pretty good class. He made a very great impression on us. In those days, I think the students had much more of a personal feeling for being a unit, and being a part of something that was important and good. For example, I think it was every month that a banquet was held. It cost money and you didn't have a lot in those days, but we always went. We never missed any of those affairs. Today, when the students hold a party, they are fortunate to have half the class attending. It was in 1936 that the first *Reflex* was published, just after we graduated, and if you look in there, you'll find a list of the social functions they had. Really, it was amazing. All the class would go.

When I went back to the school teaching in 1937, optometry students had the reputation among other faculties around the Toronto campus of being very lively. Optometry students worked hard and they played hard and they really had good parties.

CJO:

Of the various subjects you took as a student, did you consider some to be more important than others?

TF:

Oh well, that is a truth, even with the students today. You feel you've come to learn optometry, to learn how to examine eyes and provide that kind of care. I can well remember one student in our class in the biology lab. He got rather annoyed, took his scalpel and threw it into the top of the desk. It was quivering there, and he said, "Damn it, I didn't come here to learn how to cut up rabbits, I came to learn how to examine eyes." There was a fair amount of that. They felt that these other subjects were unimportant. On the other hand, I think they were important and give you a good basic background on the functioning of the body. But I would say the optometry subjects were much more interesting, and useful. At least we thought they were more useful.

CJO:

How do you view the various external influences that have affected the development of our curriculum going back over the years, . . . social attitudes, medical opposition, etc.?

TF:

Undoubtedly, there has been some medical opposition, but I think that optometry is actually a bit paranoid about it. I believe that there's actually not as much as we think. Sometimes, it becomes very apparent, and seems to be almost an economic jealousy and an economic concern of medicine. But it is there. In 1940, for example, the statement was made that optometrists could not recognize disease, and I think perhaps there was some truth to that in the early days, if you look back. We stepped up the sciences related to that aspect very much about 1940. The basic curriculum grew and I think it was worthwhile that this developed.

But the other part, that you know, is that back in 1900, many *medical* people couldn't recognize ocular disease either. In 1940, we were still in the very early stages of the 62 years that optometry has been legalized in Ontario. I think we've come a long, long distance, much more than medicine did in its first 60 years, or dentistry in its first 60 years. But I guess we've benefitted to some degree from the pressures they experienced. I regret very much that ophthalmology still has on its books the ruling that it's unethical to teach optometry. I think it's a sign that Canadian ophthalmology hasn't grown up, especially since a similar ruling has been taken off the books in the United States.

CJO:

In the earlier interview, when you were describing your initial steps in looking at various universities as potential sites for a School of Optometry, looking at the University of Toronto, for example, at the University of Waterloo, McMaster, Carleton, Ottawa University etc., you mentioned you were carrying on your own evening private practice at the same time. Do you feel that your experience in private practice has been beneficial to your career as an educator?

TF:

Oh, I definitely feel it has. When I had a practice in Toronto, it used to be the rule that all of the students had to spend one day with me on Saturdays. They would come, one at a time, and spend the entire Saturday there; that's when the classes were smaller in the 50's. Most of them said they tended to get a great deal out of just seeing how a practice would operate. For my own part, I used the practice primarily as a hobby; I used to experiment with new ideas and new techniques, and I would get new instruments that the school couldn't afford to get, simply to try them out. That happened on several occasions. Sometimes, of course, I would just borrow them, but other times I would buy them. I bought a contact lens trial set, for example, that cost about $1200.00, a lot more at that time than it seems today. It's in our museum now. I used it on three patients and then discarded it because it didn't seem to be satisfactory. Then I went to the moulding method of contact lenses; I bought all my own material in the office, and I'd bring it over to the school to show the students. The practice really helped in that way.

Nowadays, as a practical rule, I feel that all instructors should attempt to spend some time out in a private practice to determine what the public needs are, in terms of optometrical services, and what problems are being encountered.

CJO:

Doesn't the clinical environment at Waterloo satisfy that need?

TF:

There are many problems in managing the number of students and the number of patients, and the clinical environment presents a problem. For example, you'll see a patient in the clinic and do what you feel is required. Then he comes back on a different day with complaints and, because of scheduling problems, you never hear about it. One never even learns that there's been a problem with your prescription or diagnosis. There is also the fact that dealing with patients in the clinic is a very formalized situation. The patient comes in, is examined, the fee schedule is set. The patient doesn't like that, or something arises, and there are questions asked. Well, that's company policy, as it were, and that's it. If, on the other hand, you have to face the patient and explain it directly in your own office, it is much different. I think most students will agree with that. When they get out, it's almost a shock to them. Oh, they can do the techniques; they can do the examination much better than I ever could when I started. They can do all of that, but the actual meeting with the public in a private practice is considerably different than it is in the clinic.

Then there is the other question of not being aware of the final results of your work, of not having the patient back two weeks later to check things through, which you might want to do, which makes it very, very difficult. I realize why it happens, though; it's purely a scheduling problem in the clinic. You cannot possibly schedule it the way you can a private office.

CJO:

How many patients is the clinic capable of handling?

TF:

I am not aware of the number today, but when we planned the building, we figured that we would be able to see 60 or 70 patients per day, in a teaching arrangement. Now a teaching arrangement takes twice, or maybe three times longer as the same procedure does in private practice, depending on the level of the student. But we had figured about 60 or 70 a day in total, during the academic year. In the summer, it's run on more of an emergency schedule and fewer patients are seen.

CJO:

When you were doing graduate work at the University of Toronto, you got your M.A. in experimental psychology and, we understand, did work with infrared . . .

TF:

Actually, that was later . . .

CJO:

But we have the impression that you were at that time investigating the principles that are involved with a lot of the automatic equipment now on the market.

TF:

Yes, and I didn't have enough knowledge or enough guidance to complete it. When I came onto the staff in 1937, I took all the extra subjects that had been added when it was made a three-year course. I went to university as an undergraduate, I took an extra year of optics, of physiology, of pathology and everything else. I did this because I wanted the knowledge for my own benefit.

By 1945, I was taking a lot of night courses too. I took what they called the pass course for teachers, for my Arts degree. I completed a B.A., had almost completed it by the time I came on as a full-time faculty member in 1945, which was part of the reason I took a full-time position at the school.

In 1946, I completed my B.A. and in September, I went to the university and found that I could continue on a part-time basis towards a Masters degree in Psychology. I took all the courses that were required, but my Master's research was oriented more towards the vocational guidance level. For that thesis, I did a survey of optometrists and found out that their scoring was on a test called the Strong Vocational Interests Test. I actually developed a scoring scale for optometrists for that test. There were already scoring scales for physicians, dentists and many other professions and vocations; I set up a scale for optometrists.

I was just in the throes of writing my thesis when Dean Thompson died, so I said to the secretary, "I guess I'll have to give it up for this year." And Anne Anderson said, "You will not. If you have to come back here nights, I'll come back here with you; I will type it; I will retype it; we'll work Saturdays; we'll work weekends, whatever it takes." She was the secretary of the school from 1937 until she died. Anne was a very conscientious young lady who had been brought up through the depression, knew what work was and really did a job on the secretarial work. I got my M.A. largely because of her.

After that (I had just suddenly been made Dean), I went to the university and said I'd like to carry on for a Ph.D. That was fine. I took the courses you had to take. I became certified in both German and French, another requirement which meant extra courses. And you had to do a research project.

I was going to do a project on Consensual Accommodation in the Dark-Adapted Eye. I was going to stimulate one eye with a light source, while the other eye would be completely dark-adapted, and work within infrared radiation for measuring. It was just before the Vietnamese war, and there had been a great deal of work done on a device called a Snooperscope, an infrared detecting device which was used on rifles, and could enable soldiers to see targets in the dark because it detected infrared radiation. Well, I couldn't get the materials here to make the device, so I personally made about three trips to Buffalo to locate the parts. I obtained them, and got it working, but I wasn't enough of an electronics man to really make it function properly. I had a lab in the basement of university college, and the process was going to be an infrared measurement of ocular refraction. Theoretically, all the accommodation changes that took place could be measured in the dark, when the other eye was stimulated. That's what I was working on. Unfortunately, I couldn't get any help; I couldn't get any guidance from the psychology people; it was difficult to get electronics technicians to do this sort of thing, and I just fiddled. In fact, I never even took the apparatus out of the basement at university college; somebody else must have taken it out or, for all I know, perhaps it is still there!

Editor's Note:

In our next issue, we will continue with the interviews conducted with Drs. Clair Bobier and Bill Lyle.

POSITIONS AVAILABLE
UNIVERSITY OF WATERLOO

Clinical Supervisors

For clinical service and associated teaching. Applicants should have the O.D. degree and qualify for licensure in Ontario.

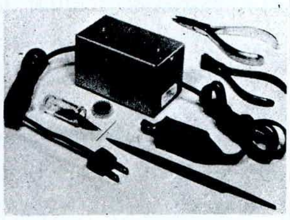
Salary negotiable within a range commensurate with experience and qualifications.

Reply to: **D.B. Buck,**
Chief of Clinics,
University of Waterloo,
School of Optometry,
Waterloo, Ontario.
N2L 3G1

PLASTIC FRAME REPAIR KIT

Make repairs on plastic frames in seconds; bridges, rims and temples all can be satisfactorily repaired. No glue, cements or epoxy. Repair results in a metal reinforcement buried electrically.

$74.50 in U.S. FUNDS postpaid. Check must accompany order. Satisfaction guaranteed.



U.S. PATENT 3,820,221 — Canadian and Japanese patents

Mercer Enterprises, 306 Bell Building/Toledo, Ohio 43624

Why can't we explain refractive error?

J.C. Bear*

This essay is respectfully dedicated to the memory of Monroe J. Hirsh, O.D., Ph.D., 1917-1982, whose research and scholarship have been an inspiration for my own efforts.

Abstract:

Refractive error is a quantitative trait, and its variation is readily considered from the point of view of quantitative genetics, or genetic epidemiology. This article reviews the development of refractive error in childhood, and its epidemiology and genetics. There is considerable epidemiological evidence that the development of refractive error is influenced by vision activity. Possible influences of other environmental factors such as nutrition have not been sufficiently investigated. Observed familial resemblances in refractive error are consistent with a considerable additive genetic contribution to variation in the range of low to moderate error; higher errors may be more strongly inherited. Recent investigations suggest vision activity, as a feature of common familial environment, can inflate measures of genetic resemblance if not taken into account. The significance of refractive error as an indicator of liability to serious ocular disorders is outlined, and suggestions made of advice to offer persons concerned about the occurrence or recurrence of refractive error in their families.

Abrégé

Un defaut de réfraction est une caractérisque quantitative et ses variantes se décrivent en termes de génétique quantitative. Ce travail discute du développement des erreurs de réfraction dans l'enfance ainsi que de leur epidemiologie et de leur herédité. Il y a suffisamment de preuves pour supporter que le développement d'un vice de réfraction est influencé par l'activité visuelle. Jusqu'à date la récherche n'est pas concluante que d'autres facteurs, comme la diète, influence le developpement. Les ressemblances familiales de la réfraction supporte l'idée d'un effect cumulatif de l'héridité dans la variante des faibles et moyennes erreurs de réfraction. Les grandes erreurs subiraient une influence heriditaire plus forte. Des études récentes suggèrent que l'activité visuelle, manifestie dans un environment familiale commun, veut fausser les données de ressemblance génétique si on l'ignore. On fait allusion à la possibilité de prédire si une erreur de réfraction puisse devenir une affection oculaire serieuse. Enfin on suggère des moyens de conseiller des personnes ou des parents inquiets de l'existence d'un vice de réfraction chez leurs enfants ou autre membre de la famille.

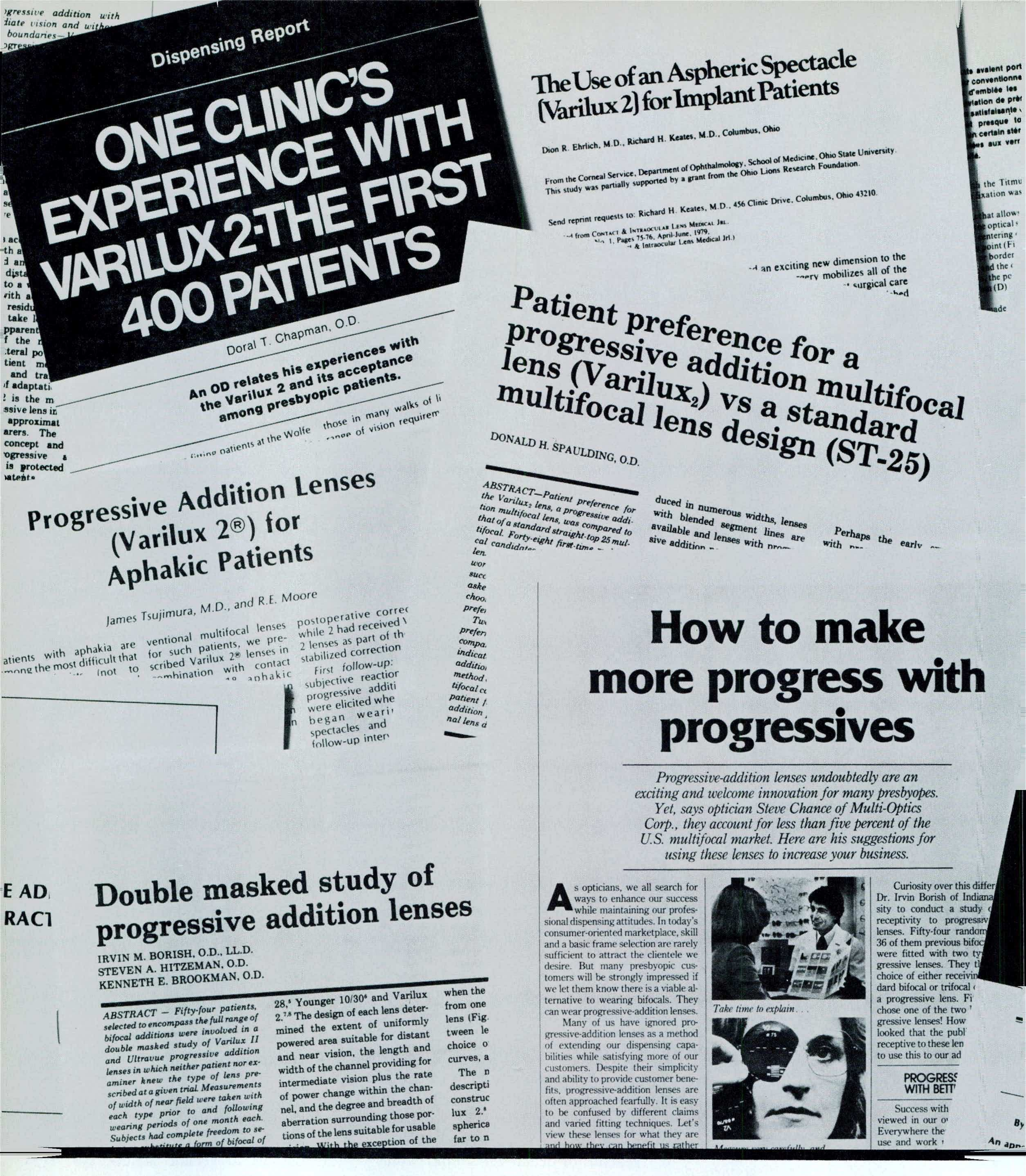
Introduction

When your editor asked me at the Biennial Congress in St. John's to write this note for CJO, he suggested I refer to Dr. Hirsch's (1) article "What you always wanted to know about myopia, but never dared to ask." The first of many perceptive observations in that article is, that if you want something to be read, you must give it a provocative title. "A review and synthesis of recent studies in the biology, epidemiology and genetics of ocular refraction" won't do, even though this was more or less what I understood was wanted, along with some suggestions of information patients and parents of children with refractive errors might find useful in understanding these conditions. Like Hirsch, having got you to start reading, I now admit my duplicity. Unlike Hirsch, who wrote from long and extensive experience, I must however admit that my presumptuousness is great, because I have no experience in the measurement of refractive error, and became seriously interested in this attribute only recently, as a result of being drafted onto the committee supervising Avrum Richler's Ph.D. research (2). In short, my acquaintance with the topic is general, not specific. On the other hand, considering a topic in a rather general context sometimes improves insight.

The viewpoint of this article is that of quantitative genetics. As the name suggests this is the genetics of quantitative traits, of attributes like height and refractive error, which are measured, as opposed to for instance ABO blood group antigens, which are counted. Quantitative genetics is also an approach which makes allowance for environmental influences in trait variation. In fact, the quantitative genetics of man is coming to be thought of as genetic epidemiology (3). Using a variety of statistical analyses, quantitative geneticists attempt to evaluate the resemblances of various sorts of relatives for a quantitative trait, such as refractive error (hereafter RE), and from these resemblances to assess the proportions of total population variation in the trait attributable to genetic factors, environmental variation, and interactions of genotype and environment. The genetic factors have traditionally been treated as if they were numerous and acting in an additive manner, with effectively

---

*Ph.D.
Division of Community Medicine
Memorial University of Newfoundland
St. John's
Newfoundland A1B 3V6



Dispensing Report

ONE CLINIC'S EXPERIENCE WITH VARILUX 2-THE FIRST 400 PATIENTS

Doral T. Chapman, O.D.

An OD relates his experiences with the Varilux 2 and its acceptance among presbyopic patients.

The Use of an Aspheric Spectacle (Varilux 2) for Implant Patients

Dion R. Ehrlich, M.D., Richard H. Keates, M.D., Columbus, Ohio

From the Corneal Service, Department of Ophthalmology, School of Medicine, Ohio State University. This study was partially supported by a grant from the Ohio Lions Research Foundation.

Send reprint requests to: Richard H. Keates, M.D., 456 Clinic Drive, Columbus, Ohio 43210.

Patient preference for a progressive addition multifocal lens (Varilux$_2$) vs a standard multifocal lens design (ST-25)

DONALD H. SPAULDING, O.D.

ABSTRACT—Patient preference for the Varilux$_2$ lens, a progressive addition multifocal lens, was compared to that of a standard straight-top 25 multifocal. Forty-eight first-time …

Progressive Addition Lenses (Varilux 2®) for Aphakic Patients

James Tsujimura, M.D., and R.E. Moore

How to make more progress with progressives

Progressive-addition lenses undoubtedly are an exciting and welcome innovation for many presbyopes. Yet, says optician Steve Chance of Multi-Optics Corp., they account for less than five percent of the U.S. multifocal market. Here are his suggestions for using these lenses to increase your business.

As opticians, we all search for ways to enhance our success while maintaining our professional dispensing attitudes. In today's consumer-oriented marketplace, skill and a basic frame selection are rarely sufficient to attract the clientele we desire. But many presbyopic customers will be strongly impressed if we let them know there is a viable alternative to wearing bifocals. They can wear progressive-addition lenses.

Many of us have ignored progressive-addition lenses as a method of extending our dispensing capabilities while satisfying more of our customers. Despite their simplicity and ability to provide customer benefits, progressive-addition lenses are often approached fearfully. It is easy to be confused by different claims and varied fitting techniques. Let's view these lenses for what they are and how they can benefit us rather …

Take time to explain . . .

Double masked study of progressive addition lenses

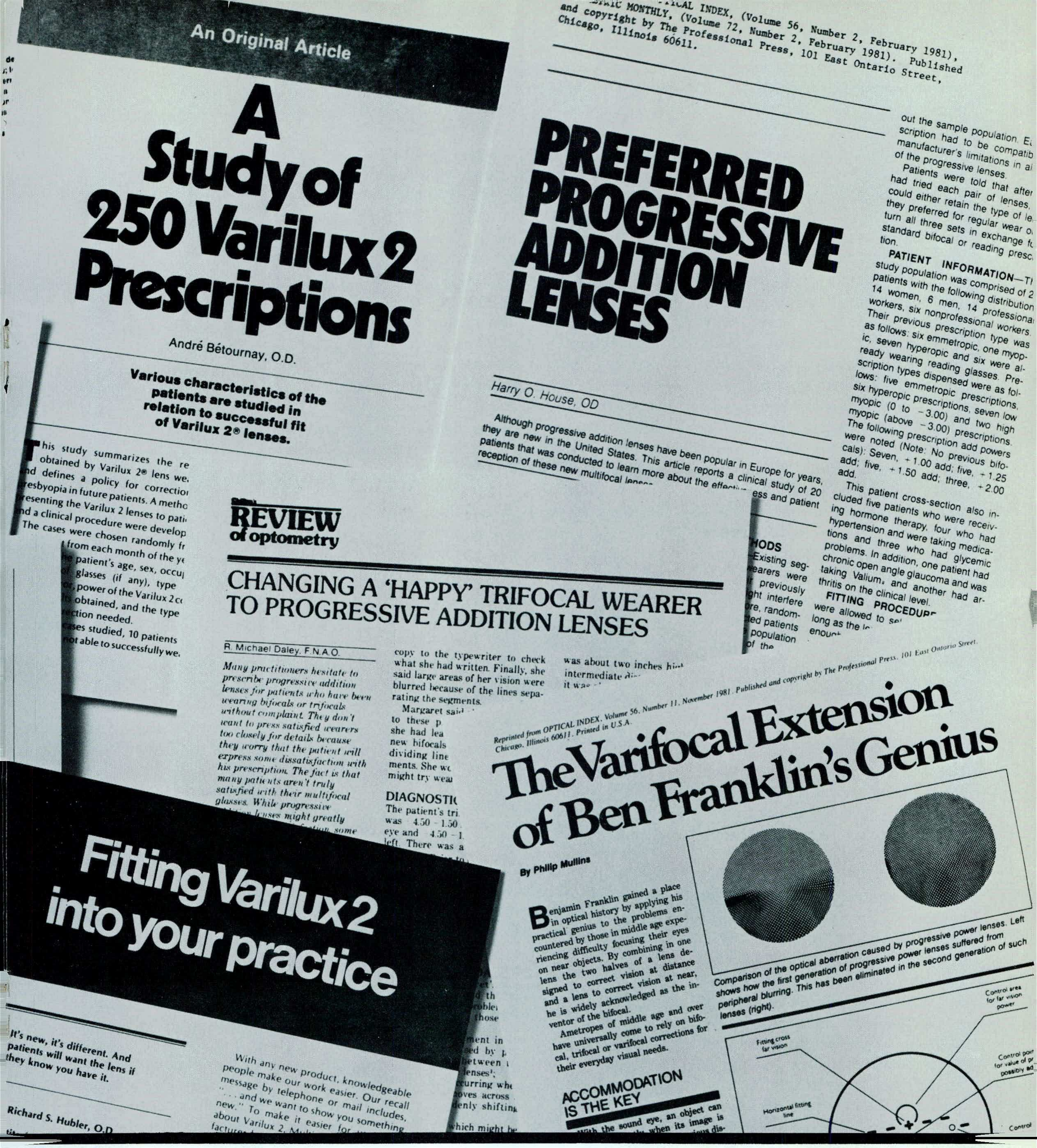
IRVIN M. BORISH, O.D., LL.D.
STEVEN A. HITZEMAN, O.D.
KENNETH E. BROOKMAN, O.D.

ABSTRACT — Fifty-four patients, selected to encompass the full range of bifocal additions were involved in a double masked study of Varilux II and Ultravue progressive addition lenses in which neither patient nor examiner knew the type of lens prescribed at a given trial. Measurements of width of near field were taken with each type prior to and following wearing periods of one month each. Subjects had complete freedom to se…

28,[5] Younger 10/30[6] and Varilux 2.[7,8] The design of each lens determined the extent of uniformly powered area suitable for distant and near vision, the length and width of the channel providing for intermediate vision plus the rate of power change within the channel, and the degree and breadth of aberration surrounding those portions of the lens suitable for usable …

Numerous studies and tests* have been conducted by professionals in North America. The results show that **VARILUX 2** is THE solution to the modern living requirements of presbyopic patients.

* Test results available on request.



An Original Article

A Study of 250 Varilux 2 Prescriptions

André Bétournay, O.D.

Various characteristics of the patients are studied in relation to successful fit of Varilux 2® lenses.

This study summarizes the re
obtained by Varilux 2® lens we
nd defines a policy for correctio
resbyopia in future patients. A metho
resenting the Varilux 2 lenses to pati
nd a clinical procedure were develop
The cases were chosen randomly fr
from each month of the y
e patient's age, sex, occu
of glasses (if any), type
or, power of the Varilux 2 c
ly obtained, and the type
rection needed.
ases studied, 10 patients
not able to successfully we

ICAL INDEX, (Volume 56, Number 2, February 1981),
TRIC MONTHLY, (Volume 72, Number 2, February 1981). Published
and copyright by The Professional Press, 101 East Ontario Street,
Chicago, Illinois 60611.

PREFERRED PROGRESSIVE ADDITION LENSES

Harry O. House, OD

Although progressive addition lenses have been popular in Europe for years, they are new in the United States. This article reports a clinical study of 20 patients that was conducted to learn more about the effecti ess and patient reception of these new multifocal lens

HODS
Existing seg-
earers were
r previously
ght interfere
re, random-
ed patients
population
of the

out the sample population. E
scription had to be compatib
manufacturer's limitations in a
of the progressive lenses.
Patients were told that after
had tried each pair of lenses,
could either retain the type of le
they preferred for regular wear o
turn all three sets in exchange f
standard bifocal or reading presc
tion.

PATIENT INFORMATION—T
study population was comprised of 2
patients with the following distribution
14 women, 6 men, 14 professiona
workers, six nonprofessional workers.
Their previous prescription type was
as follows: six emmetropic, one myopic, seven hyperopic and six were already wearing reading glasses. Prescription types dispensed were as follows: five emmetropic prescriptions, six hyperopic prescriptions, seven low myopic (0 to −3.00) and two high myopic (above −3.00) prescriptions. The following prescription add powers were noted (Note: No previous bifocals): Seven, +1.00 add; five, +1.25 add; five, +1.50 add; three, +2.00 add.

This patient cross-section also included five patients who were receiving hormone therapy, four who had hypertension and were taking medications and three who had glycemic problems. In addition, one patient had chronic open angle glaucoma and was taking Valium, and another had arthritis on the clinical level.

FITTING PROCEDUR
were allowed to se
long as the le
enou

REVIEW of optometry

CHANGING A 'HAPPY' TRIFOCAL WEARER TO PROGRESSIVE ADDITION LENSES

R. Michael Daley, F.N.A.O.

Many practitioners hesitate to prescribe progressive addition lenses for patients who have been wearing bifocals or trifocals without complaint. They don't want to press satisfied wearers too closely for details because they worry that the patient will express some dissatisfaction with his prescription. The fact is that many patients aren't truly satisfied with their multifocal glasses. While progressive

copy to the typewriter to check
what she had written. Finally, she
said large areas of her vision were
blurred because of the lines separating the segments.
Margaret sai
to these p
she had lea
new bifocals
dividing line
ments. She w
might try wea

DIAGNOSTI
The patient's tri
was 4.50 - 1.50
eye and 4.50 - 1
left. There was a

was about two inches hi
intermediate di
it wa

Reprinted from OPTICAL INDEX, Volume 56, Number 11, November 1981. Published and copyright by The Professional Press, 101 East Ontario Street, Chicago, Illinois 60611. Printed in U.S.A.

The Varifocal Extension of Ben Franklin's Genius

By Philip Mullins

Benjamin Franklin gained a place in optical history by applying his practical genius to the problems encountered by those in middle age experiencing difficulty focusing their eyes on near objects. By combining in one lens the two halves of a lens designed to correct vision at distance and a lens to correct vision at near, he is widely acknowledged as the inventor of the bifocal.

Ametropes of middle age and over have universally come to rely on bifocal, trifocal or varifocal corrections for their everyday visual needs.

ACCOMMODATION IS THE KEY

With the sound eye, an object can
when its image is

Comparison of the optical aberration caused by progressive power lenses. Left shows how the first generation of progressive power lenses suffered from peripheral blurring. This has been eliminated in the second generation of such lenses (right).

Fitting cross far vision
Horizontal fitting line
Control area for far vision power
Control poin for value of pr possibly ad
Control

Fitting Varilux 2 into your practice

It's new, it's different. And patients will want the lens if they know you have it.

Richard S. Hubler, O.D.

With any new product, knowledgeable people make our work easier. Our recall message by telephone or mail includes, ". . . and we want to show you something new." To make it easier for about Varilux 2. Mul

THOUSANDS OF PROFESSIONALS HAVE FOUND THE SOLUTION...

VARILUX 2 — the only aspherical progressive lens.

ESSILOR®

equal influences on trait variation, but allowance can be made for the possibility that particular genes have large effects on trait variation. Generally, environmental factors are not individually specified, though they can be. This approach is not very specific, compared to what can be said about gene action and environmental influence in an ever-increasing number of instances; quantitative genetic analysis should supplement and guide more specific investigations, rather than supplant them. When, however, influences on trait variation seem numerous, and none seems of overwhelming importance, as I shall argue is the case for RE, such analyses may provide useful insight and guidance in suggesting more specific investigations that should be undertaken. I shall not attempt to review quantitative genetics here; the standard text is by Falconer (4), and an excellent article by Spivey (5) is available in the vision literature. A good starting point for review of the recent human genetic literature is the comprehensive text by Vogel and Motulsky (6).

The Variable

At the outset, it is worth stating clearly, for present purposes, what RE is taken to mean. Following Hirsch's (1) lead, discussion is here confined to errors resulting from underlying variation in axial length, which make up the bulk of RE in the general population. To anticipate conclusions, but in an attempt to avoid prejudicing them, high RE, arbitrarily those outside ± 6D, are excluded from consideration; this will be explained shortly. An emphasis on myopic errors is unavoidable, as these have been studied much more extensively than hyperopia or emmetropia. In short, as the *usual* answer to the question "Why is my child myopic?" it can be said "The child's eyes have grown too large or long for images to be focussed sharply on the retina." As to why the eyes are too large or long, there are no simple answers.

In quantitative terms, RE shows a continuous, unimodal population frequency distribution, like height or weight or blood pressure, with values for most persons clustering around the population mean, in emmetropia, and progressively fewer values toward the hyperopic and myopic extremes. The population distribution of RE is also unusually peaked, or tightly clustered about the mean (leptokurtotic, in statistical terms). The extreme values of this population frequency distribution are "pathological", requiring therapeutic amelioration. A quantitative geneticist or epidemiologist would wonder whether these extremes are perhaps qualitatively as well as quantitatively different from errors in the middle of the distribution, those accepted as more of less "normal". Most investigators share this outlook — it characterizes the work of Hirsch (1) and many others. An understanding of total population variation in RE is thus a pre-requisite to explaining its extreme values. These may be simply the "tails" of the population variation, or they may result from more specific causes, such as generalized clinical disorder, environmental factors or genes of large effect relative to other influences on variation, or pathological interactions of constitution with environmental insult; all of these possibilities are known to occur in high RE (7).

Identification of the factors influencing population variation in RE, as well as any specific factors associated with extreme values, might be expected to yield ideas as to how the occurrence of extreme errors as well as moderate RE might be lessened or prevented. At the end of this paper, I will outline the importance of identifying such factors.

Changes with Age

In populations of children followed over time, it has been amply demonstrated that the population distribution of RE shifts toward myopia as the children grow older (8-10). This shift parallels increases with age in the population mean of length of the optic axis (10). Axial length and RE are strongly correlated throughout the normal range of refraction, as well as in high myopia and hyperopia (11).

As a group, myopes show a higher rate of axial elongation and of refraction change than do emmetropes and hyperopes. It is not correct, however, to think of myopes as a group distinct from the rest of the population by virtue of a higher rate of axial growth. Relatively great axial elongation is observed in a proportion of children with hyperopic and emmetropic initial refractions as well, and seems as often to decrease hyperopia as to increase myopia (12, 13). Presumably high hyperopia reflects a short axis that elongates little (12). "Rapid growth" appears to be simply one end of a roughly balanced, normal distribution of ocular growth (12), and though most myopic eyes are probably in part too large or long as a result of ocular growth in childhood and adolescence, it is more productive to think in terms of a distribution of axial elongation influencing a distinct distribution of initial RE, pushing, as far as myopia is concerned, some emmetropes to myopia and most myopes to more extreme myopic values. Consistent with this is the variable rate of progress, from none to considerable, observed in uncomplicated (14) and in high (15) myopia.

In relating growth of the eye to RE, it is important to remember that the anatomical deviation underlying even large RE is relatively slight. A departure of one millimeter from the average axial length of 24 mm implies 3D of RE, other things being equal. This 4% deviation in an anatomical dimension causes considerable inconvenience, whereas a similar difference in height, say from a mean value of 173 cm. to a 4% greater value of 180 cm., would excite little comment or difficulty. Moreover, this 1 mm is the order of normal increase in axial length from age 3 to age 13 years, an interval during which height increases on the order of 60%, but refraction usually changes even less than the 1 mm elongation would imply, because decreases in lens and cornea power usually compensate for the axial elongation (10). This is the source of the leptokurtosis of the population distribution of RE, that is of the relative excess of low RE values over what would be expected were the association of components of refraction random (1). These relationships, and the very complexity of the eye, indicate elaborate genetic control of ocular growth and development must be assumed *a priori.* But, considering the other side of the coin, RE must be exquisitely sensitive to genetic and environmental perturbations influencing the size and shape of the eyeball.

Some Genetics

From this biological background, consideration of the population genetics and epidemiology of RE can commence. Any factor influencing the growth of the eye must be suspected to influence RE also. Several such influences have been postulated on logical and sometimes laboratory data, but the convincing demonstration of their actions and interactions in individuals and populations may be very difficult.

As just indicated, genetic control of RE is likely but is unlikely to be absolute. Genetic variation must be suspected to account for some of the population variation in RE for two reasons. First, numerous single gene conditions are known which include unusual RE among their manifestations (16), establishing that genetic variation in RE is possible. Second, RE depends upon ocular dimensions, and correlations between related individuals are generally found both for anatomical dimensions (4, 17) and for growth in these dimensions (18). Indeed, modest correlations among relatives — offspring with parents and sibs with one another — are generally observed for RE (19-23) and for ocular dimensions (20-23). The RE correlations run on the order of 0.2-0.3, values less than those usually found for anthropometrics such as stature, but indicating that, if the simplest assumptions of quantitative genetics are made (see Introduction), as much as 40-60% of total population variation in RE might be attributable to genes of small effect acting additively. Qualifications are, however, necessary.

What applies for the general population may not be a good description of the situation in individual families. High RE probably results, in many instances, from the transmission in families of genes of large effect. Such families are properly excluded in making genetic estimates for the bulk of the population, since they are genetically distinct, their frequency is unknown, and the high RE is sometimes only one part of a more general ocular disorder. Setting aside such cases, the genetic component in variation in the general population cannot be thought of simply as something which, added to variation attributable to environmental factors, gives total population variation in RE, even though the calculations imply this. Individuals may respond to environmental influences in different ways, and genetic differences between the individuals may underlie these differences in response. Moreover, close relatives share a common environment as well as common heredity, and factors of familial environment relevant to variation in RE may be inflating the correlations of relatives compared to those that would be observed were these factors of common environment not operating. These points will be taken up again after reviewing the epidemiology of RE. The observed familial correlations may be taken to suggest heredity accounts for a substantial proportion of population variation in RE, but they may not give a very accurate impression of the size of this.

Some Epidemiology

Knowledge regarding the epidemiology of RE is not extensive. Its salient features are these:

a. The distribution of RE is nonliterate peoples with hunting and gathering economies is shifted toward hyperopia by comparison with that found in urbanized literate populations (24-26). Incidentally (for purposes of present discussion) extremes of RE and poor visual acuity from whatever cause are relatively rare among hunter/gatherers, consistent with the reasonable suggestion that reduced visual acuity confers a severe selective disadvantage in such modes of life (27).

b. Among Alaskan Eskimo and Canadian Eskimo and Amerind peoples myopia is uncommon among older persons, but myopia (predominantly of mild degree) is common among persons born since World War II. These are the first among these people to be substantially exposed in childhood to aspects of standard North American culture such as compulsory schooling and processed foods (23, 28, 29).

c. In Denmark, on the other hand, the association of RE with level of education, as evaluated in representative samples of male conscripts, remained constant for 80 years from 1882 to 1964. More educated groups showed considerably more myopic distributions than did less educated groups, the proportion with myopia greater than 1.5D showing a graded decrease from 30% of men academically qualified to enter University to 3% of unskilled workers. The total proportion of men with mild or moderate myopia was little changed in the 80 year interval (30).

d. Recent investigations in a rural Newfoundland population (31) found a general, fairly consistent and graded association of RE with nearwork activity as reported by the subjects of the investigation, myopic errors being correlated with higher levels of nearwork, intermediate errors with intermediate levels, and hyperopia with lower levels. This association was found to persist in persons aged 5-60 years despite age trends in RE toward myopia below and hyperopia above the age of 20 years, and despite much better formal education being available to persons aged 30 years and under than to older persons. It seems improbable that the members of this population were subtly adjusting their nearwork activity to their RE, and much more likely that nearwork was influencing RE. The regression coefficients relating RE to nearwork were on the order of -.2 to -.4 D/hr of nearwork/day, depending on age, after adjustment by linear regression for age, sex and education. This suggests the potential for nearwork to influence refractive error is considerable, since the levels of education and nearwork activity reported in this population were not high. It is obviously desirable that a similar investigation be carried out elsewhere to assess the generality or not of these findings.

e. There is rather more myopia in the United States than in Europe. Some 14.5% of Danish males aged 18-20 (30) and some 10.7% of British males aged 18-22 (32) were found to have minus RE of any degree in 1964 and 1960 respectively, but some 25-30% of males of those ages, in a representative survey sample of the U.S. population studied in 1971-72, wore corrective lenses indicating minus RE (33).

Nearwork is the only environmental factor which must clearly be suspected on the basis of accumulated epidemiological evidence to influence RE. Plausible mechanisms for this influence have been suggested: the accommodative effort which accompanies nearwork increases intraocular (vitreous chamber) pressure, and might cause the globe to increase in size and the RE to become more myopic (34, 35). The accommodative capacity of myopic 18-year olds is superior to that of emmetropes and hyperopes, sometimes greatly so, and change in RE between the ages of 10 and 18 years has been found to be correlated with accommodative power at age 18 (36). That this mechanism in fact operates, or is this simple, is however by no means proven, primarily because young myopes, by virtue of their myopia, do not need to accommodate to see clearly in doing nearwork (36). Studies of the amount of accommodative effort children actually make would be of value and are being undertaken in Denmark (Dr. E. Goldschmidt, personal communication). As an alternative hypothetical mechanism by which nearwork might lead to an increase in axial length, it seems possible that the tensions exerted by the extraocular muscles in effecting convergence to view near objects is sufficient to increase intraocular pressure greatly for short periods, and irreversibly deform the sclera at the posterior pole of the globe, where it is weaker (37, 38).

The association observed of RE with nearwork must not preclude consideration of other possibilities for environmental influence. An influence of nearwork on refraction was suggested by Kepler in 1611, a few years after he correctly described the optics of the eye, and has thus been suspected for almost as long as ocular refraction has been correctly understood (7, 30). Such an association has been vigorously sought without much regard for other environmental factors which might be varying along with nearwork and confounding observations.

The most important of these is nutrition. Diet can clearly influence growth rate, and its composition tends to change as a result of the same social forces that change the nearwork regime. Thus, a hunting and gathering population is often introduced to schooling and radical diet changes, such as a sudden abundance of refined carbohydrates, at about the same time. Suspicion of confounding of such simultaneous effects must be entertained in evaluating the changing myopia incidence in the Canadian North, for instance (23). It is very difficult to evaluate diet composition, particularly in retrospect, so this point may well remain moot for some time. Reports to date (39-41) associating specific dietary excesses or deficiencies with RE are difficult to interpret, since it is not clear what allowance they make for nearwork and social class variation. Available data suggest the eye is to a remarkable extent spared from otherwise general growth retardation in man and animals (42). Indeed, while grossly malnourished (marasmic) infants are less hyperopic than adequately nourished infants, this difference seems reversible with correction of the malnutrition (43).

Since rate of change of RE seems related to rate of growth of the eye, it is reasonable to attempt to relate refractive error directly to growth. Most attempts have been aimed at finding an association of RE with stature, and have found none once the associations of both RE and stature with social class are taken into account (44). Sorsby et al. (12), in relating changes in axial length and changes in RE to changes in height and weight in children followed longitudinally, found no indication that rate of overall growth was related to rate of change in RE or axial length. These workers were able to study relatively few subjects and though not easy to collect, more data on these relationships would be valuable, since the association sought is probably weak. In this context, it is noteworthy that the mean stature of Danish conscripts increased 10 cm. from 1860-1960 (44), consistent with the secular trend in stature observed very generally in Europe which seems at least partially attributable to improvements in nutrition (45), whereas in this time interval no change could be detected in the general distribution of RE in these men (30).

Taking together what data are available on the association of RE with diet, growth and stature, it seems fair to conclude that if variation within usual North American and European diets does indeed influence RE, this influence is either small, or is a function of composition rather than quantity. The growth of the eye in early childhood deserves much more study (10, 12), but in broad terms growth of the eye parallels that of the head as a whole, being largely complete well before adolescence, and shows no adolescent growth spurt (45). It is thus probably inappropriate and possibly misleading to seek a relationship between ocular growth and total body growth during adolescence, when the two patterns of growth are quite different (46).

Some Interactions

At this point, it is perhaps becoming apparent why we can't as yet explain RE. The questions involved and relationships sought are subtle. Family studies indicate the genetic control of RE is substantial, but not complete. Epidemiological studies implicate nearwork as *one* environmental factor influencing RE, but are not nearly extensive enough to allow specification of the extent of this influence in individual cases. More basic biological considerations suggest that any influence on growth and development could influence RE, but, ambiguously, available data are consistent with ocular growth being well protected from such perturbations. To make matters more difficult, there is little data on the progressive changes in RE with age in representative groups of children followed through adolescence, which would give population standards against which RE changes in individual children could be judged. There are as yet few data on RE and nearwork, let alone other environmental factors, collected for the same series of individuals. There are almost no data on RE and nearwork in persons related to one another, which would allow investigation of familial resemblances in RE with allowance for environmental effects. Thus, evaluation of genotype/environment interactions underlying the population distribution of RE is also hampered by the limited data available.

Our own investigations in Newfoundland (see reference 19 for details) emphasize the probable complexity of the situation without doing much to resolve it. As stated, in investigating RE variation in a rural Newfoundland population, ample reason was found to suspect nearwork influenced RE. Data were available on the relationships of population members to one another, and with this data it seemed appropriate to investigate whether nearwork, as an aspect of common familial environment, could inflate measures of the resemblance of close relatives to one another and thus lead to a falsely high impression of the genetic contribution to RE variation. The resemblances among sibs and the resemblances of offspring to their parents were measured using correlation and regression techniques. First, measured RE values were adjusted for the associations found of RE with age and sex, then the RE measurements were adjusted for education and nearwork levels as well. The data were treated as describing the total population rather than as a representative sample, since about 80% of the residents of the communities studied had been included in the investigation. A consistent picture emerged: the further adjustment substantially *reduced* the measures of resemblances of relatives to one another, though resemblances after further adjustment were comparable to those found in family studies elsewhere, indicating that nearwork, as an aspect of common familial environment, was inflating the resemblances.

Closer examination of the results raised further questions about the nearwork-refraction relationship, however; there were indications that the analysis did not completely separate out the influence of nearwork on refraction. This was not surprising for three reasons. First, adjustment of RE for age, sex, education and nearwork was purely by linear regression. That is, in the absence of evidence sufficient to postulate a more complicated relationship, individual RE values were adjusted for the influences of the associated variables by simply measuring their deviations from straight lines plotted through the data so as to best indicate the association of RE with each variable. Second, data were cross-sectional. That is, each subject was evaluated once only, giving only a static impression of the long term, dynamic relationships between the variables. Third, the measure of nearwork influence on RE was completely *ad hoc*, being simply the combined statistical effects of usual nearwork at the time of the investigation, as reported by the subject, and the formal education of the subject in years, which provided the only measure available of nearwork in earlier life. In summary, adjustment was statistical, not biological, and suspicions of its biological imperfections seem justified.

As an interesting sidelight, in this study persons aged less than 30 years were found to resemble their parents of like sex in RE more than they resembled their parents of opposite sex. This pattern is not explicable on any simple genetic hypothesis, but would be expected on the plausible suppositions that boys tended to acquire their nearwork habits preferentially from their fathers rather than their mothers, girls on the other hand copied their mothers, and nearwork influenced RE.

The overall implication of these findings is that not only must the interaction of heredity and environment be considered in describing population variation in RE; but moreover the variation of environmental factors among families is relevant.

It is important to realize that the observed pattern of interaction of genetic and environmental influences on RE is expected to vary among and within populations, depending on relative exposures to environmental influences. Assuming for instance that nearwork influences the RE of all persons toward myopia, RE might appear to be a strongly inherited attribute in groups doing relatively little nearwork, and probably also in groups doing generally high levels of nearwork, because the influence of nearwork on RE would in both cases be roughly equivalent on each population member. If exposure to nearwork *varied*, however, RE would appear less strongly inherited, as a result of this additional contribution to its variation in the population. If exposure to nearwork *changed*, as for example if educational opportunity improved over time, relatives of similar ages might appear more similar in RE than relatives of different ages. This is in fact the case for RE. Sibs are generally found to resemble one another in RE to a greater degree than offspring resemble their parents (see reference 19), as would be expected since educational opportunities, and presumably nearwork activity, of sibs are usually relatively similar, while educational opportunities for children have in this century generally improved substantially over those of their parents. This increased resemblance results from environmental change, not genetic factors. (The tentative nature of comparisons of RE of persons of markedly different ages must however be borne in mind in this context). If family members had similar nearwork patterns, familial resemblances would again be increased, as suspected in the Newfoundland investigations already described (19), and further complications of genotype/environment interaction can readily be imagined.

It is assumed in the preceding discussion that individuals vary little in their response to environmental influences on RE. It is not known whether this assumption is valid, but its validity is a particularly interesting question. Available data (47, see also Epidemiology section, above) are compatible with a general shift in RE distribution in the population with exposure to environmental influences. In the Newfoundland study (31), association of nearwork with RE involved not only higher levels in myopes, but also lower than average levels of nearwork in hyperopes. More specific investigations are necessary, however, before the existence of persons whose eyes are particularly sensitive to usual environmental influences can be ruled out. It is of course such specifically susceptible persons for whom environmental modification might prove most valuable in keeping RE within acceptable limits.

Presumably such susceptibility would take the form of inappropriate axial elongation, since RE is in general a result of inappropriate axial length. Even assuming these influences are general and responses uniform, persons inheriting long eyes would form a group particularly susceptible to myopia (23), while persons of intermediate axial length would be less susceptible and persons inheriting short axes might have their hyperopia environmentally reduced.

Some Advice

What advice can be given to parents concerned about the occurrence of a RE in their children sufficient to require correction, or to parents concerned that their children will have an extreme RE? Uncomplicated mild or moderate errors must be considered separately from higher errors.

For moderate or mild RE, general reassurance seems in order. Everyone has a refractive error, just as everyone is a particular height. As this review emphasizes, the background to population and familial variation in RE seems complex, and heredity and environment interact in determining a particular RE, but only general statements about this are possible at present. Variation in the range of mild to moderate RE should occasion no surprise. Children should resemble their parents in RE to some degree only, common familial environment as well as heredity may be relevant, and a substantial proportion of variation may be "random" in the sense of being unattributable statistically to any specific influence. "Therapy" in the form of corrective lenses is adequate.

Low and moderate myopes are at higher risk than are emmetropes and hyperopes to retinal detachment and glaucoma; their contribution to the prevalence of these disorders is thus disproportionately large (48). These complications are almost always of adult onset and therefore primarily the concern of the individual rather than the parent. Inappropriate anxiety must not be generated; these conditions are uncommon compared to other serious morbidities of adult onset, but they imply severe visual handicap or blindness if not vigorously treated. Everyone should be aware of the warning signs of these disorders, and the intraocular pressure of older adults routinely checked, since the overall population incidence of glaucoma is about 1/100. This is particularly so for myopes whose risk of glaucoma is about 1/35, and of glaucoma before age 50 about 1/23 (48).

The genetic and epidemiological data are primarily concerned with myopia; even less is known about hyperopia and astigmatism. Reports that these are strongly familial, based on limited and selected family data (16, 21), are difficult to interpret. A strong genetic basis would not be surprising, since the environmental factors which may influence refraction in European and North American populations would promote a shift toward myopia, and highlight familial transmission at the other end of the refraction scale. There are indications in longitudinal data that axial elongation during childhood is in some cases very slight, or does not occur. Whether the resulting hyperopic individuals form a distinct group, or the low end of a distribution of axial elongation (see Changes with age, above) is not known (10, 12). Similarly, whether this lack of ocular growth is familial is not known. Persons with high hyperopia and astigmatism should be particularly encouraged to make sure their children undergo early vision screening, since this is simple and inexpensive, and errors predisposing to amblyopia can be particularly sought out. (Vision practitioners are encouraged to collect and carefully analyse data from such families to improve genetic estimates and prognosis prediction.)

Despite the strong suspicion that nearwork may substantially influence RE, reducing hyperopia and increasing myopia, the extent of this influence is not yet known. The plausible suggestion that diet can influence RE remains at present insufficiently explored. Drastic manipulations of these or other environmental factors, aimed at "preventing" or reducing RE are unjustifiable at this time (49). This is not meant to rule out the possibility of specific intervention being developed in the future, particularly for higher errors, but such intervention should be proportionate to the problem; myopia is much less a handicap than malnutrition or illiteracy.

High myopia has serious implications. It is a common cause of blindness, particularly blindness of onset below old age. About 14% of cases of registered blindness are attributable to high myopia, a proportion almost equal to that attributable to diabetic retinopathy or to congenital defects (primarily retinitis pigmentosa). The usual causes of blindness in high myopia are chorioretinal atrophy and hemorrhage, and less often retinal detachment (48). Risk of retinal detachment rises dramatically with degree of myopia (48). These complications appear to be mechanical failures resulting from the inordinate axial length (50, 51). High myopia is clearly familial; some cases presumably represent extremes of the population distribution of refractive error and axial length, but in addition many pedigrees have been collected suggesting the action of genes of large effect, and inheritance of high myopia with other ocular defects (7, 16). Genetic counselling should be based on any familial pattern apparent, but often none will be and empiric risks of a child being affected must then be given (52). Referral of concerned patients to a genetic counsellor is appropriate.

The risk of blindness in high myopia, and the disproportionate association of significant ocular morbidity with lower degrees of myopia, provide ample justification for continuing to investigate refractive error at the population level. Further stimuli to research include the association of vision handicap with high hyperopia, the considerable aggregate expenditure for correction of mild and moderate RE, and the indications that high errors are in a sense "diseases of civilization" which are particularly common, for unknown reasons, in North America. In reviewing myopia research ten years ago, Hirsch (1) emphasized as much what he didn't know as what he did know. Over the intervening decade, some progress is apparent in our knowledge of refractive error, but ignorance still overshadows knowledge, while the reasons for dispelling that ignorance have become much more sharply defined.

Acknowledgements

Discussions with many people have helped me both directly and indirectly in developing the ideas outlined here. In the specific context of this article, I must acknowledge my particular indebtedness and gratitude to Drs. Avrum Richler, Ernst Goldschmidt, Gordon Johnson and Maurice Belanger. M. Fennessey and D. Williams carefully prepared the manuscript.

References

1. Hirsch M.J. What you always wanted to know about myopia, but never dared to ask. *Canadian Journal of Optometry* 34: 54-66 (1972).
2. Richler A. Thesis: A study of ocular refraction in western Newfoundland. St. John's, Memorial University of Newfoundland (1979).
3. Morton N.E., Outline of Genetic Epidemiology. S. Karger, Basel (1982).
4. Falconer D.S. Introduction to Quantitative Genetics. Oliver and Boyd, Edinburgh (1960).
5. Spivey B.E. Quantitative genetics and clinical medicine. *Transactions of the American Ophthalmological Society* 74: 661-707 (1976).
6. Vogel F., Motulsky A.G. Human Genetics. New York: Springer-Verlag (1979).
7. Duke-Elder S., Abrams D. Ophthalmic Optics and Refraction. Vol. V *in* Duke-Elder, S. (ed) System of Ophthalmology. St. Louis: C.V. Mosby Co. (1970).
8. Hirsch M.J. The refraction of children. Chapter 5 *in* Hirsch M.J., Wick R.E. (eds) Vision of Children. Philadelphia: Chilton Books (1963).
9. Young F.A., Beattie R.J., Newby F.J., Swindal M.T. The Pullman study — a visual survey of Pullman school children, Part II. *American Journal of Optometry and Archives of the American Academy of Optometry* 31: 192-203 (1954).
10. Sorsby A., Benjamin B., Sheridan M., Stone J., Leary G.A. Refraction and its components during the growth of the eye from the age of three. Medical Research Council Special Report Series No. 301. London: Her Majesty's Stationery Office (1961).
11. Gernet H. Oculometric findings in myopia. *Doc. Ophthal. Proc.* Series 28: 71-77 (1981).
12. Sorsby A., Leary G.A. A longitudinal study of refraction and its components during growth. Medical Research Council Special Report Series No. 309. London: Her Majesty's Stationery Office (1970).
13. Fledelius H.C. Changes in refraction and eye size during adolescence. *Doc. Ophthal. Proc.* Series 28: 63-69 (1981).
14. Rosenberg T., Goldschmidt E. The onset and progression of myopia in Danish school children. *Doc. Ophthal. Proc.* Series 28: 33-39 (1981).
15. Goldschmidt E., Fledelius H.C., Erlin Larsen F. Clinical features in high myopia. *Doc. Ophthal. Proc.* Series 28: 233-244 (1981).
16. Sorsby A. Ophthalmic Genetics. New York: Appleton-Century-Crofts (1970).
17. Roberts D.F., Billewicz W.Z., McGregor I.A. Heritability of stature in a West African population. *Annals of Human Genetics* 42: 15-24 (1978).
18. Roberts D.F. Genetics of growth. *British Medical Bulletin* 37: 239-246 (1981).
19. Bear J.C., Richler A., Burke G. Nearwork and familial resemblances in ocular refraction: a population study in Newfoundland. *Clinical Genetics* 19: 462-472 (1981).
20. Sorsby A., Leary G.A., Fraser G.R. Family studies on ocular refraction and its components. *Journal of Medical Genetics* 3: 269-273 (1966).
21. Young F.A., Leary G.A. The inheritance of ocular components. *American Journal of Optometry and Archives of the American Academy of Optometry* 49: 546-555 (1972).
22. Alsbirk P.H. Refraction in adult West Greenland Eskimos. *Acta Ophthalmologica* 57: 84-95 (1979).
23. Johnson G.J., Matthews A., Perkins E.S. Survey of ophthalmic conditions in a Labrador community. I. Refractive errors. *British Journal of Ophthalmology* 63: 440-448 (1979).
24. Holm S. Les états de la réfraction oculare chez les palénégrides au Gabon, Afrique Équatoriale Française. *Acta Ophthalmologica Supplementum* 13 (1937).
25. Skeller E. Anthropological and ophthalmological studies on the Angmagssalik Eskimos. *Meddelelser om Grønland* 107: 4 (1954).

26. Taylor H.R. Racial variations in vision. *American Journal of Epidemiology* 113: 62-80 (1981).
27. Post R.H. Possible cases of relaxed selection in civilized populations. *Humangenetik* 13: 253-284 (1971).
28. Young F.A., Leary G.A., Baldwin W.R., West D.C., Box R.A., Harris E., Johnson C. The transmission of refractive errors within Eskimo families. *American Journal of Optometry and Archives of American Academy of Optometry* 46: 676-685 (1969).
29. Woodruff M.E., Samek M.J. A study of the prevalence of spherical equivalent refractive states and anisometropia in Amerind populations in Ontario. *Canadian Journal of Public Health* 68: 414-424 (1977).
30. Goldschmidt E. On the etiology of myopia. *Acta Ophthalmologica* Supplementum 98 (1968).
31. Richler A., Bear J.C. Refraction, nearwork and education: a population study in Newfoundland. *Acta Ophthalmologica* 58: 468-478 (1980).
32. Sorsby A., Sheridan M., Leary G.A. Vision, visual acuity, and ocular refraction of young men. *British Medical Journal* i: 1394-1398 (1960).
33. Roberts J., Rowland M. Refraction status and motility defects of persons 4-74 years, United States, 1971-1972. DHEW Publication No. (PHS) 78-1654. National Center for Health Statistics, Hyattsville MD. (1978).
34. Young F.A. The development and control of myopia in human and subhuman primates. *Contacto* 19: 16-31 (1975).
35. Young F.A. Intraocular pressure dynamics associated with accommodation. *Doc. Ophthal. Proc.* Series 28: 171-176 (1981).
36. Fledelius H.C. Accommodation and juvenile myopia. *Doc. Ophthal. Proc.* Series 28: 103-108 (1981).
37. Greene P.R. Mechanical considerations in myopia: relative effects of accommodation, convergence, intraocular pressure, and the extraocular muscles. *American Journal of Optometry and Physiological Optics* 57: 902-914 (1980).
38. Ku D.N., Greene P.R. Scleral creep in vitro resulting from cyclic pressure pulses: applications to myopia. *American Journal of Optometry and Physiological Optics* 58: 528-535 (1981).
39. Gardiner P.A. Dietary treatment of myopia in children. *Lancet* i: 1152-1155 (1958).
40. Lane B.C. Calcium, chromium, protein, sugar and accommodation in myopia. *Doc. Ophthal. Proc.* Series 28: 141-148 (1981).
41. Lane B.C. Elevation of intraocular pressure with daily sustained closework stimulus to accommodation, lowered tissue chromium and dietary deficiency of ascorbic acid (vitamin C). *Doc. Ophthal. Proc.* Series 28: 149-155 (1981).
42. Young F.A., Leary G.A., Zimmerman R.R., Strobel D.A. Diet and refractive characteristics. *American Journal of Optometry and Archives of the American Academy of Optometry* 50: 226-233 (1973).
43. Halasa A.H., McLaren D.S. The refractive state of malnourished children. *Archives of Ophthalmology* 71: 827-831 (1964).
44. Goldschmidt E. Myopia and height. *Acta Ophthalmologica* 44: 751-761 (1966).
45. Tanner J.M. Human growth and constitution *in*: Harrison G.A., Weiner J.S., Tanner J.M., and Barnicot N.A. (eds.) Human Biology 2nd ed. Oxford: Oxford University Press (1977).
46. Sorsby A. Biology of the eye as an optical system. Chapter 34 *in* Duane TD (Ed) Clinical Ophthalmology, revised edition. Hagerstown MD: Harper and Row (1980).
47. Richler A., Bear J.C. The distribution of refraction in three isolated communities in western Newfoundland. *American Journal of Optometry and Physiological Optics* 57: 861-871 (1980).
48. Perkins E.S. Morbidity from myopia. *The Sightsaving Review* 49: 11-19 (1979).
49. Belanger G.M. Controlling the refractive state of the human eye. *Canadian Journal of Optometry* 43: 116-118 (1981).
50. Curtin B.J., Karlin D.B. Axial length measurements and fundus changes in the myopic eye. *American Journal of Ophthalmology* 71: 42-53 (1971).
51. Karlin D.B., Curtin B.J. Myopia and chorioretinal lesions. *American Journal of Ophthalmology* 81: 625-635 (1976).
52. Bergsma D. (ed.) Birth Defects Atlas and Compendium 2nd ed. New York, Alan R. Liss (1979).

OPTOMETRIST

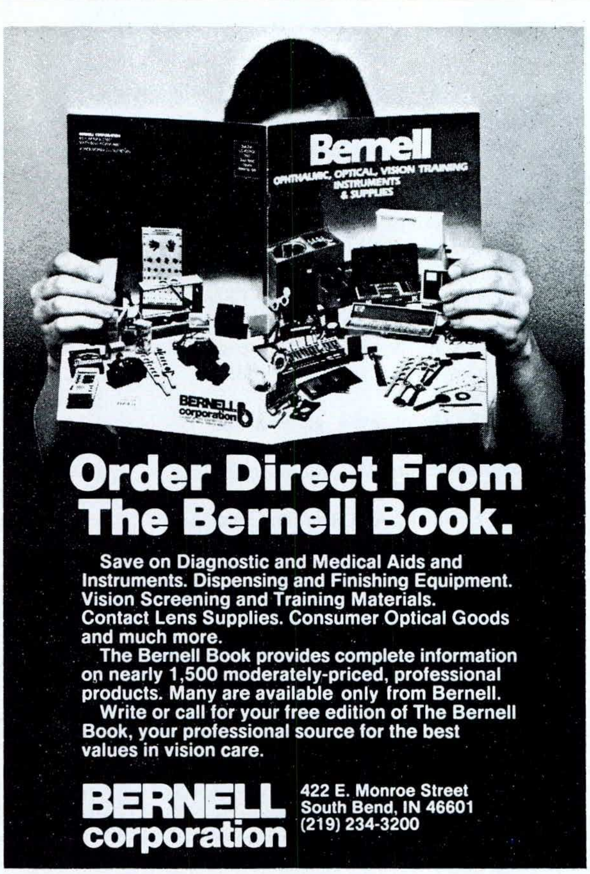
An established, member-owned co-operative clinic requires an optometrist to join in the preventive team approach to health care. Recent graduates will be considered.

Current services include: physicians, nursing, X-Ray, laboratory, physical therapy, social services, chiropody, community day care, optical dispensing, and a variety of health education programs.

This is a salaried position offering an excellent benefit package. Applications and enquiries may be directed in confidence to:

Executive Director
Regina Community Clinic
3765 Sherwood Drive
Regina, Saskatchewan
S4R 4A9
Telephone (306) 543-7880

FOR SALE
Topcon Retinal Camera Model TRC-FE
High-quality, easy to produce colour retinal photos, including anterieur segment photos.
1 year old (New $8,000.00). Will sell for $6,000.00
Dr. G. Evans — (604) 562-1305



Order Direct From The Bernell Book.

Save on Diagnostic and Medical Aids and Instruments. Dispensing and Finishing Equipment. Vision Screening and Training Materials. Contact Lens Supplies. Consumer Optical Goods and much more.

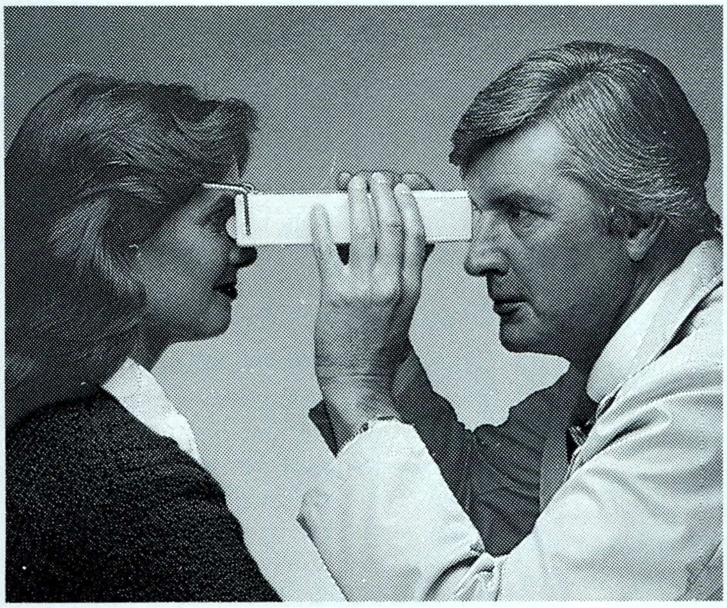
The Bernell Book provides complete information on nearly 1,500 moderately-priced, professional products. Many are available only from Bernell.

Write or call for your free edition of The Bernell Book, your professional source for the best values in vision care.

BERNELL corporation
422 E. Monroe Street
South Bend, IN 46601
(219) 234-3200

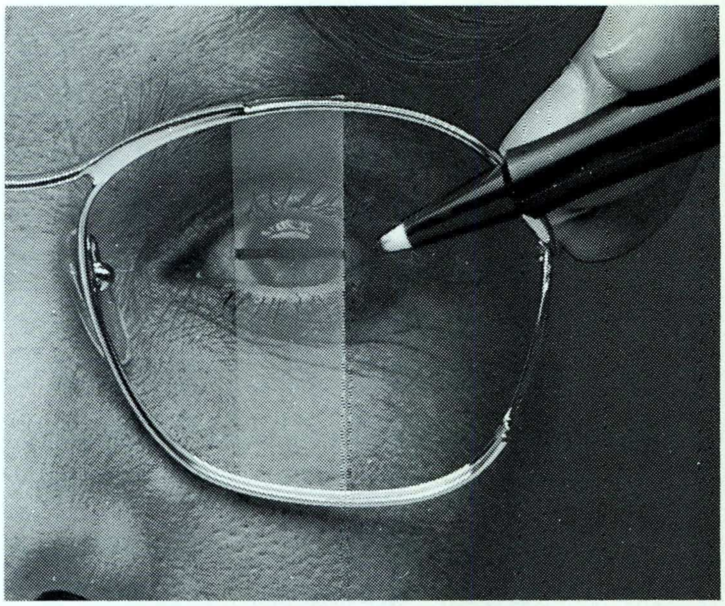
VARILUX 2

IT'S SIMPLE



Measure monocular pupilary
variation easily and
with precision.

IT'S EASY



Determine
height of adjustment
for each eye.

Over 30 million **VARILUX** wearers prove that **VARILUX** is the easy and simple solution to presbyopic persons' requirements.

EACH VARILUX LENS IS ENGRAVED «V2»

VARILUX 2 the only aspherical progressive lens

ESSILOR®

Retinal Photography Without Mydriatics

Yves J. Alloucherie*

Abstract

Two main reasons may be given to explain why retinal photography is not used more frequently by optometrists: the high cost of the specialized cameras required and the "need" for mydriasis. It is of course true that fundus cameras, like all other complex optical instruments, are expensive. It will however be shown in this paper that very acceptable photographs of the retina may often be obtained easily, even by inexperienced optometry students, without any drug-induced mydriasis, after only a few minutes of instruction and experience.

Abrégé

Deux raisons principales peuvent être données pour lesquelles peu d'optométristes prennent des photos du fond d'oeil: le coût élevé des appareils requis et la "nécessité" d'employer des drogues mydriatiques. Il est évident que les caméras de fond d'oeil, comme tout autre instrument optique compliqué, sont dispendieuses. Le présent travail a cependant démontré qu'il était souvent facilement possible, même pour des étudiants en optométrie sans expérience préalable, d'obtenir des photos de la rétine d'une bonne qualité, après seulement quelques minutes d'instruction et d'expérience, et sans mydriase artificelle.

Introduction

The myth that drug-induced mydriasis is essential for success in retinal photography is unfortunately reinforced by some camera manufacturers. For instance, the instruction manual of the Topcon Retinal Camera Model TRC-F[1] clearly states that "If the pupils are not dilated completely, illumination will not be sufficient for photography. (The pupil diameter should be over 7 mm)."

According to Duke-Elder[2], a minimum pupillary diameter of at least 5 mm is required. This advice unfortunately resembles that given in certain ophthalmology texts[3], where the reader is admonished that direct ophthalmoscopy should routinely be performed with dilated pupils, or that accurate retinoscopy should be determined with cycloplegics for patients less than 46 years of age. There are of course certain cases when mydriatics and/or cycloplegics should be used, but this does not mean that useful results cannot be obtained without them.

The results described below have shown that retinal photographs of acceptable quality may frequently be obtained easily without any drug-induced mydriasis: furthermore, the operators involved were not highly skilled clinicians, but third-year optometry students without any prior experience in retinal photography.

Protocol

A simple training program was organized to teach third-year optometry students at the University of Montreal the use of retinal photography. The instrument used was a standard Topcon Model TRC-F retinal camera. The program involved three basic steps:

1. Instruction in the basic controls of the instrument
2. Practice in focussing and photography using schematic eyes
3. Practice in focussing and photography using human eyes

The film type used throughout was a DIRACOLOR (very similar to KODACOLOR) color negative model, with ratings of 100 ASA or 21 DIN, and was processed commercially. After some experimentation, the following instrument settings were found to give good results:

Illumination filter plate:	1/2
Filter switching knob:	1/3
Illumination control switch:	low to medium
Flash control switch:	50

It should be explained that two optical filters can be adjusted independently on the instrument: the "illumination filter plate" controls the amount of incident light striking the retina, while the "filter switching knob" controls the amount of light reflected from the retina and entering the camera system. This distinction is important since, as was pointed by Leutwein and Littman[4], a large pupillary diameter is not necessary for photography per se, but only for retinal illumination, since only a small part of the incident light is reflected. The "illumination control switch" controls the amount of steady-state light used prior to photography proper to focus and center the camera (then used as an ophthalmoscope) on the area of interest. Finally, the "flash control switch" controls the brightness of the electronic flash illumination used for the actual photography.

The above control settings correspond to the recommended values given in the instrument user's manual.

Two schematic eyes were used for demonstration and practice:

1. A Bernell cylindrical eye normally used for retinoscopy practice, with a pupillary diameter of about 10 mm, modified by the addition of a simple internal cardboard shell drawn to simulate a retina.

---

*O.D., Ph.D., Clinical Resident, School of Optometry, University of Waterloo, Waterloo, Ontario N2L 3G1.

2. A.M.I.R.A. eye normally used for binocular indirect ophthalmoscopy practice, with a pupillary diameter of about 6 mm.

Finally, photographs of human retinas were taken by the students on each other. The room light was turned off and the illumination control switch was set as low as possible to prevent excessive myosis. Prior use of schematic eyes with large pupils greatly facilitated this step.

The total training time per student did not exceed 15 minutes.

Results

A number of typical results are reproduced in Figs. 1-4.

Discussion

The results obtained in this study have shown that, contrary to commonly held assumptions, drug-induced mydriasis is not always absolutely essential to obtain acceptable retinal photographs. It remains to be seen if even better results could be obtained by switching off the illumination light source completely for a few seconds after focussing is completed, just prior to actually taking the photographs, leaving the eye then in complete darkness except for the very faint red fixation light. This should achieve wide natural mydriasis. Triggering the bright xenon electronic flash light will of course bring about a strong pupillary contraction but, since the latency period for myosis is about 0.2 sec (according to Adler[5]) and therefore much slower than the duration of the electronic flash or the film exposure time, the photographs would be taken with the pupil still dilated. Photographic quality could also be improved by using higher-quality slide-type films.

Conclusion

Optometrists who are unable or unwilling to use mydriatics for whatever reason should not automatically dismiss retinal photography as part of their diagnostic armamentarium. Very limited practice should give rewarding results that could be invaluable in long-term photodocumentation of patients' retinas. Patients with truly myotic pupils or lenticular opacities will still probably need to be dilated however.

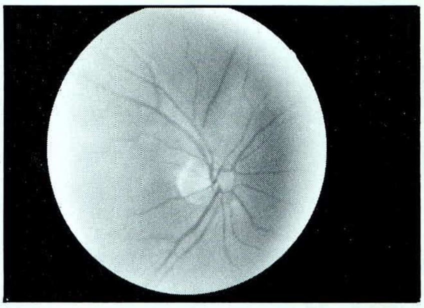


Fig. 1

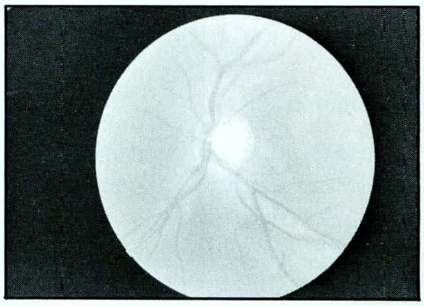


Fig. 2

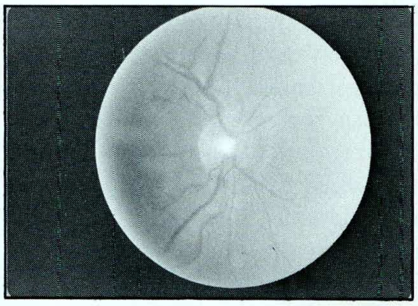


Fig. 3

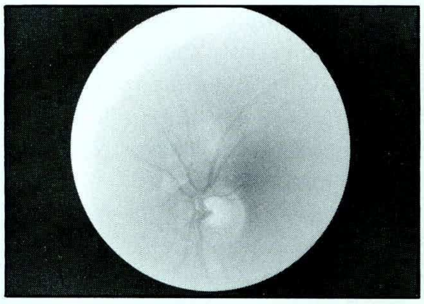


Fig. 4

References

1. User's manual, Topcon Retinal Camera Model TRC-F, Tokyo Kogaku Kikai K.K., p. 15.
2. System of Ophthalmology, Vol. VII, The Foundations of Ophthalmology, edited by Sir Stewart Duke-Elder, The C.V. Mosby Company, St. Louis, 1962, p. 306.
3. Textbook of Ophthalmology, Harold G. Scheie and Daniel M. Albert, W.B. Saunders Company, Philadelphia, 1977, pp. 177, 272.
4. The Fundus Camera, K. Leutwein and H. Littman, Duane's Clinical Ophthalmology, Vol. 1, pp. 61.2-61.3, Harper & Row Publishers, Hagerstown, 1979.
5. Adler's Physiology of the Eye, Clinical Application, edited by Robert A. Moses, Sixth Edition, the C.V. Mosby Company, St. Louis, 1975, p. 334.

PRACTICE APPRAISALS

(Goodwill & Assets)

For purposes of

Associate Buy-In
Partnership
Cost Sharing
Group Practice
Sale of Practice

Confidential Professional Services
Established 1973

ROI Management Incorporated
Mississauga, Ontario
(416) 278-4145

FEB. 16
WILL BE TOO LATE!

The **final** deadline for submitting an application for a grant under the 1983 C.O.E.T.F. Awards Program is **Feb. 15, 1983.** NO APPLICATIONS WILL BE ACCEPTED AFTER THIS DATE. An application form is on P. 201. Please use it — but before February 15, 1983.

CANADIAN
OPTOMETRIC
CONTACT
LENS
SOCIETY

La SOCIETE
OPTOMETRIQUE
CANADIENNE
des LENTILLES
CORNEENNES

The Effect Of Freeze/Thaw Conditions On Hydrogel Lens Posterior Apical Radius And Surface Quality

Lester E. Janoff*

Abstract

Twenty-six hydrogel lenses of identical parameters were subjected to twenty-five freeze/thaw cycles and periodically checked for base curve sagittal depth and surface quality. A matched group of lenses served as an untreated control. The results indicated the treatment group gave more stable measurements than the control group. No surface defects were apparent after twenty-five cycles. It may well be that the freeze/thaw cycle relieves the internal stress created by machining a complex polymer. We are confident that hydrogel lenses of simple HEMA formulations when subject to freeze/thaw conditions, are unharmed.

Abrégé

On a soumis 26 lentilles hydrogel de même composition et de même paramètres à 25 cycles de gel/dégel. A intervalles régulières on a vérifié les rayons de courbure et la qualité des surfaces. Un nombre égal de lentilles semblables ont servi de control sans subir les cycles de gel/dégel. Le groupe expérimental a manifesté plus de stabilité dans ces deux paramètres que le groupe de control. Il est possible que le cycle gel/dégel dissipe les contraintes internes résultantes des procédés d'usinage dans la fabrication. L'auteur est confiant que les lentilles hydrogel s'en tirent indemnes d'un cycle gel/dégel.

Introduction

The literature on hydrogels describes the effect of temperature variation on these materials.[1,2] Many articles on the outcome of temperature change on hydrophilic lenses concentrate on the result of increasing the temperature of the environment.[3,4] Rarely have clinicians or researchers published the aftermath of severely reduced temperatures, on hydrogel lenses.[5] There is a legitimate concern for reduced temperatures, for many practitioners have received soft lenses in a frozen state. Since manufacturers, distributors, and clinicians exist in climates subjected to freezing temperatures, often for protracted periods; it is entirely possible for a lens to pass through one or more cycles of freeze-thaw in transit from someone's inventory to the consumer. We therefore asked the question "What happens to a pristine lens immersed in a saline filled vial when subject to a series of freeze-thaw cycles?"

Does the freezing of the free and bound water within the lens cause a permanent change in the lens parameters?

Does the expansion and contraction of water when passed through the freeze/thaw cycle, affect the surface integrity?

Method and Materials

Fifty-two soft lenses, all of the same material and having the same label values were taken from our experimental lens inventory. All lenses were manufactured by machining by the same operator. This operator was also responsible for hydration and measurement of the lenses. The lenses were divided into two groups (treatment and control), and were remeasured prior to treatment by a different operator using identical equipment. Two lens parameters were selected for analysis. Base curve was selected since our measurement equipment is considered very precise and highly reliable. The base curve was measured using the Panametric ultrasonic transducer (as modified by American Optical) and temperature control within 2° centigrade* was insured during the measurement task. The other parameter evaluated was surface quality. It was felt that repeated expansion and contraction of the polymer could create surface defects visible at low magnification. Therefore, an American Optical Microstar steremicroscope was used at 15X magnification to inspect the lens for surface defects.

The freezing was accomplished in a standard household freezer (approximately -3° centigrade) for twenty-four hours. The lens was kept in a vial in 5 ml of saline. Following the freeze cycle the lens was stored at room temperature for twenty-four hours and then recycled. After five complete cycles the lenses were remeasured. On the same day the control lenses which had been standing untouched at room temperature were also remeasured. When measurement was completed the lens

---

*O.D., M.S. Director of Professional Services American Optical Corporation, Framingham, Massachusetts.

*Cell temperature for ultrasonic measurement was maintained at 23° centigrade ± 1°.

was returned to its vial and fresh saline added. After analysis of the data the lenses were returned for five more cycles (a total of ten), and the measurement technique repeated. The lenses were once again returned to the freeze/thaw environment for fifteen more cycles (total of 25). A final analysis was then made.

Results

The lens used was an investigational one made of an approved polymer of 55% water content. Prior experience with this material led us to anticipate a slight steepening of the base curve over time when a lens stood unattended. Figure 1 is a graph of the control group mean sags measured ultrasonically over a period of almost four months. These lenses were subjected to fluctuations in room temperature over a maximum of 2° centigrade. The increasing sag height (change from 0 cycles to 25 cycles is + .036 mm or slightly in excess of 0.1 mm steeper in base curve radius) is as expected.† Note also the increasing variability of the measurements with time (the limit bars of the graph represent one standard deviation). A student "t" test between the 0 cycle mean and 5 cycles mean rejects the null hypothesis ($t = 4.84$: $P > .001$, $df = 24$) indicating a significant difference between the means. The control lenses of 5 cycles do not appear to be from the same population as the control lenses of 0 cycles. This represents about one month of standing time.

Figure 2 is the same display of the results for the treatment group. In contrast to our control lenses there is a pronounced stability for base curve measurements, and if any trend; one slightly toward a flatter base curve. Variability of measurements seems unaffected and a "t" test between 0 cycles and 5 cycles accepts the null hypothesis that these lenses are from the same population ($t = -0.33$: $p =$ N.S., $df = 24$) or not significantly different.

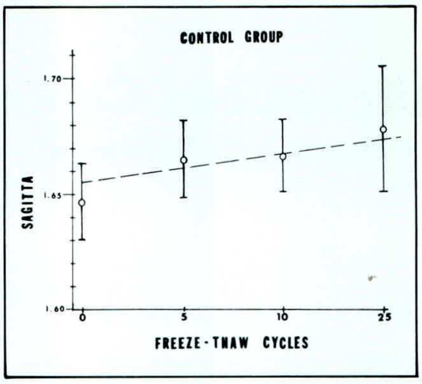


Figure 1: Base Curve Means and Standard Deviations of Untreated Control Lenses Measured at Same Time as Treated Lenses.

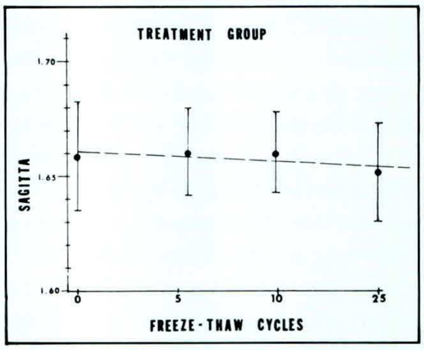


Figure 2: Base Curve Means and Standard Deviations of Freeze/Thaw Treatments for Up to 25 Cycles.

Examination of lenses with the microscope at all stages was unremarkable. One lens from the treatment group showed a surface scratch from handling after ten cycles, and it was no worse after twenty-five cycles.

Discussion

It is quite clear from this investigation that for the hydrophilic polymer tested, twenty-five cycles of freezing and then thawing had no damaging effect upon the lens. No surface defects were visible. Although we did not test all the material properties, the handling quality for treated lenses seemed no different than those of the untreated controls. The lens base curve was essentially unchanged by the twenty-five freeze/thaw cycles. However, for this polymer the stabilization of base curve represented an unusual condition. It is suspected that, simple, HEMA formulations will be unefffected by freeze/thaw conditions. It is our new hypothesis that complex copolymers of HEMA will be stabilized by freezing. The expansion and contraction the lens undergoes during the freeze/thaw cycle could relieve internal stress in a lens created by the machining process. Under the usual conditions of gradual hydration without agitation as applied to our control lenses, the slow relief of internal stress results in a shortened base curve radius (and probably a smaller diameter as well).

It is our suspicion that freezing for even a lengthly period has no detrimental effect upon a simple hydrogel of HEMA. Complex HEMA copolymers might benefit from freezing for it may relieve machining stresses quickly and produce a more stable product. Whether this applies to other hydrogels (pyrollidones, acrylamides, etc.) needs to be tested. How other polymer characteristics or lens parameters respond to freezing might also be studied. We at least feel more confident when we say that a HEMA lens the dispenser receives frozen in the vial, can be thawed and used without fear of the consequences. Just let it thaw at room temperature and dispense it with the confidence that it is unadulterated.

References

1. Hermans, P.H., Gels, In Kruyt, H.R. (ED.), *Colloid Science* Vol. 2, Elsevier Publishing Co., New York, 1969.
2. Refojo, M., *Contact Lens Encyclopedia of Polymer Science and Technology*, Supplement, John Wiley and Sons Inc., New York, 1976, PP 195-219.
3. Chaston, J. and I. Fatt, The Influence of Temperature on the Base Curve of High Plus Contact Lenses, *ICLC*, 8 (1): 42-50, 1981.
4. Janoff, Lester E., The Consequence of Temperature Change on Hydrophilic Lens Base Curve in Gels of Varying Water Content, *ICLC*, 9 (4): 228-32, 1982.
5. Refojo, M., Materials in Bandage Lenses, *Contact Lens IOLJ*, 5 (1): 34-44, 1979.

Acknowledgements

We appreciate the assistance of Mrs. Claudia Savary who performed all lens evaluations for base curve sagittal depth and surface quality.

---

†Tests of reliability for this instrument and this polymer allow acceptance of a single reading at the 95% confidence level within a range of ± .015 mm of sag. (AO report J1-1218 L.E. Janoff).

Ocular Irritation and Contact Lenses

Howard A. Backman†

Abstract

A number of causes of ocular irritation from the use of hydrogel lenses are examined in relation to the onset of G.P.C., kerato conjunctivitis, keratitis and infiltrative conjunctivitis.

Abrégé

L'irritation oculaire peut provenir de plusieurs sources. Ce travail examine certaines causes en fonction du début d'une kératite infiltrative, d'une kerato-conjonctivite, ou d'une conjonctivite papillaire géante.

Ocular irritation may be caused by lens deposits, by worn out lenses or damaged lenses, by chemicals employed in the cleaning and disinfection of lenses and microbial contamination of lenses. The purpose of this paper is to examine the relationship between these factors and Giant Papillary Conjunctivitis, (G.P.C.), keratoconjunctivitis or infiltrative keratotis, and immunology of the patient.

Lens deposits

Proteinaceous deposits are produced by the accessory lacrimal glands. These deposits are layered and lenses are 50% coated with mucus within the first 30 minutes of wear and by eight hours wear the lenses may be 90% coated[1]. During the first three months about 10% of the patients would have accumulated enough debris to change the function and comfort of the lens[2]. By the end of six months, 50% of the lenses would be showing significant debris. At the end of one year, more than 80% of lenses would be functioning at a less than satisfactory level because of surface coating. Convex surfaces and higher water content lenses seem to develop more deposits. The presence of deposits may necessitate the replacement of soft contact lenses every 18 to 24 months.

Cleaning and disinfection of lenses

There are two procedures which may be used to clean lenses, surfactant cleaning of superficial deposits which accumulate daily and enzymatic cleaning to reduce chemically bound muco-protein deposits. Some cleaners emulsify the proteinaceous layer breaking them up into droplets on the surface of the lens which can be removed by rubbing the lens surface. No cleaner is effective in removing all the layers of deposits[1].

Disinfection is a procedure designed to kill bacteria and spores by means of either heat or chemical agents. The pores in soft lenses are impermeable to bacteria unless defects in the material are present due to poor quality control in manufacturing, and the effect of handling and aging of the lenses. There are also other ways in which lenses can become contaminated. Bacteria, including Pseudomonas Aeriginosa[3] adhere to deposits on the lens surface.

Bacteria are unlikely to proliferate on a surface unless they can attach to the surface of the lens coating. It has been hypothesized that contact lenses may provide a surface on which bacteria can proliferate and provide antigenic mass[3]. Bacteria may come from the skin and is transferred to the lens or may even be present in the solutions used in cleaning and disinfecting lenses. For example, of 17 open bottles of Hydrocare solution tested, 10 were found to be contaminated with bacteria such as Pseudomonas and Serratia liquefociens. Lens cases may contain contaminated solutions[4]. A lack of compliance on the part of the patient may also be a source of lens contamination and ocular irritation[6].

A study of the chemical and microbiology assays on 29 hydrogel lenses from 20 patients was performed with three chemical systems and lenses made of three types of materials[7]. The chemical analyses revealed amounts of zinc, magnesium, silver, cadmium and, in one case, copper which had been absorbed through medication taken for colitis. These chemicals discoloured lenses and created G.P.C., infiltrative keratitis and intolerance to the lenses[7]. Bacteria were found in 18 lenses from 13 patients. In 6 out of 9 cases tested a new strain of Pseudomonas 11 K type 1 was found which is often present in distilled water. Other organisms present were Pseudomonas Aeriginosa, Enterobacter Aerogenes and Corny-bacterium pseudo dipthericum. The chemicals absorbed in the lenses and bacterial contamination created 7 discoloured lenses within the first 12 months of use. Problems such as G.P.C. and or infiltrative Keratitis commenced in 15 patients within 24 months. It seems that soft contact lenses should be changed after a year due to lens contamination which may produce visual and ocular disturbances.

Immunological Response

Giant Papillary Conjunctivitis (G.P.C.) is a syndrome characterized by excess mucus, ocular itching, diminished or destroyed contact lens tolerance and giant papillae (0.3mms in diameter) in the upper tarsal conjunctiva. The syndrome develops in wearers of soft contact lenses after as few as three weeks and after as long as four years of daily successful wear. The cause of G.P.C. is probably immunologic because of the nature of the cellular infiltrate. It was hypothesized that "the antigen

---

†O.D., Pierrefonds, Quebec.

*paper read at 2eme Colloque Int'l sur la Lentille de Contact, 11-12 Oct. 1980, Quebec.

initiating the disease is in the deposit on the lens and not the lens material itself, because when the patient wears a new (clean) lens of the same material or an old lens from which deposits have been totally removed, the syndrome improves or disappears. No one particular type of lens seems to be responsible for the problem; it has been seen in all types of both soft and hard lenses. The occurence of lymphocytes, plasma cells, basophils and eosinophils indicates that there may be a similarity between G.P.C. and a type of delayed basophilic cutaneous hypersensitive reaction."[8]

Some patients wearing contact lenses exhibit latent hypersensibility reactions and are unable to tolerate any type of contact lens. The presence of a contact lens may create an antigen-antibody reaction, or the lens coating may attract antigens such as pollens and inhalants increasing the hypersensitivity reaction markedly. The resultant mucus discharge and antigen adhering to the contact lens surfaces may create blurred vision, discomfort and intolerance to the lenses.[9,10]

Keratoconjunctivitis with G.P.C. has been observed in approximately 4% of the soft contact lens population[11]. The cornea shows punctate staining and infiltrates around the superior and inferior limbi. This condition does not respond to medical treatment and resolves over a period of several months without treatment. It may be of bacterial, viral or immunologic origin. Excessive deposits on soft lenses are a constant feature of G.P.C. and Infiltrative Keratitis. As symptoms continue to develop it may become more difficult to keep the lenses clean. A scanning electron microscope has been used to study the surfaces of coated soft lenses from patients with G.P.C.[12]. All worn contact lenses differed strikingly from new, never-worn lenses. Thick coatings on lenses from patients with G.P.C. and asymptomatic wearers were similar. It seems that the capacity to develop G.P.C. may be influenced by individual differences more than by differences in the lens deposits and is probably created by a combination of mechanical, immunologic and inflammatory mechanisms[13].

Conclusion

Several factors associated with the wearing of hydrogel lenses may produce an inflammatory response which reduced tolerance to the lenses. Deposits, chemicals used in cleaning and disinfection, bacterial contamination and allergies may affect lens wear. These factors may reduce the life of the lens; therefore, patients should be examined frequently and their lenses inspected with the biomicroscope for defects, deposits and discolouration. Problems usually commence in the second year of wearing lenses because of deterioration of the lenses. Patients should be advised that there is a limited life expectancy of soft lenses which varies with use, maintenance and the environment. A new material for soft contact lenses should be developed which is just as comfortable, more durable, and easier to maintain than existing materials.

References

1. Fowler, S.A.; Allansmith, M.R.: Evolution of soft contact lens coatings *Arch. Ophth.* 98: 95-99, 1980.
2. Morgan, J.F.; Mills, J.A.; Blaine, J.F.: Blood constituents and hydrophilic lens coating, *Contact Lens,* 3:4, Oct./Dec. 1977.
3. Fowler, S.A.; Greiner, J.V.; Allansmith, M.R.: Attachment of Bacteria to soft contact lenses. *Arch. Ophth.* 97: 659-660, 1979.
4. Angers, C. Ocular microbiology: A protocol for clinical studies, paper presented to Am. Academy of Optom. Anaheim, Cal. Dec. 1979.
5. Roth, H.W.: The etiology of ocular irritation in soft lens wearers, *Contact & Intraocular Lens Mes. Jrl.* 2:4, 38-46, April/June 1978.
6. Roth, H.W.; Roth-Wittig, M.: Multipurpose solutions for soft lens maintenance *Int. Contact Lens Clinics,* 3:17, May/June 1980.
7. Backman, H.A.: A preliminary investigation of the aging of soft contact lenses, *Int. Contact Lens Clinics,* 2:7, March/April 1980.
8. Allansmith, M.R.; Korb, D.; Greiner, J.V.; Henriquez, Simon M.A.; Finnemore, V.M.: Giant Papillary Conjunctivitis in contact lens wearers, *Am. J. Ophth.* 5:83, 1977.
9. Backman, H.A.; Bolte, C.: Chronic Allergie Conjunctivitis and its effect on contact lenses. *Optom Weekly.* Sept. 5, 1974.
10. Backman, H.A.: Identification of Patients' intolerance to contact lenses. *Review of Optom.* April 1977.
11. Josephson, J.E.; Caffery, B.E.: Infiltrative keratitis in hydrogel lens wearers, *Int. Contact Lens Clinics,* 5:6, Sept./Oct., 1979.
12. Fowler, S.A.; Greiner, J.V.; Allansmith, M.R.: Soft contact lenses from patients with Giant Papillary Conjunctivitis, *Am. J. Ophth.* 88, 1056-1061, 1979.
13. Richmond, P.P.: Giant Papillary Conjunctivitis a closer look, *Am. J. Optom.* 3:51, 252-254, March 1980.

Season's Greetings

Meilleurs Voeux

The
President,
Council
and Staff
of
The Canadian Association
of Optometrists

ABSTRACTS

A series of studies has been published recently in the medical literature which is relevant to the management of soft contact lens patients. The researchers have utilized scanning electron microscopy to examine surface deposits on soft lenses. Previous studies have provided strong evidence that such lens deposits contribute to the development of giant papillary conjunctivitis. The abstracts of four studies are presented to provide the reader with an overview of important recent work in this area.

Soft contact lenses from patients with giant papillary conjunctivitis. Fowler, S.A., Greiner, J.V. and Allansmith, M.R. *Am. J. Ophthalmol.* 88(6): 1056-1061, June 1979.

Scanning electron microscopy was used to examine the surfaces of three categories of soft lenses. These included never-worn lenses, lenses with heavy surface coating from patients with lens-associated giant papillary conjunctivitis, and lenses with similar heavy surface coating from asymptomatic patients. The never-worn lenses were strikingly cleaner than the worn lenses but no significant differences could be seen between the two types of worn lenses. The anterior surfaces of the lenses showed thick deposits with a trabeculated morphology having surface debris which appeared to be mucus, bacteria and cells. The deposits on the posterior surfaces of lenses were much smoother. These findings support the concept that individual patient differences are more influential in the development of giant papillary conjunctivitis than differences in lens deposits.

Brian Garnett O.D.

Evolution of soft lens coatings. Fowler, S.A. and Allansmith, M.R. *Arch. Ophthalmol.* 98(1): 95-99, Jan. 1980.

To investigate further the reported possibility that surface deposits on soft contact lenses contribute to giant papillary conjunctivitis, we performed scanning electron microscopy on 22 lenses worn for varying durations by a group including persons who had never worn contact lenses and asymptomatic persons who had, and on five never-worn lenses. Thirty minutes' wear resulted in covering of about 50% of the anterior surface with scattered cell-membrane-like and mucus-like material, with mucus-like material on top of cells in places. Eight hours' wear produced about 90% covering with more complex coatings. Routinely worn and cleaned lenses had still more complex coatings on more than 90% of the surface. Deposits were found on routinely worn lenses even after professional cleaning. We conclude that all worn soft contact lenses have coatings that become more complex with time and may never be removed completely.

Author's Abstract.

The surface of the continuously worn contact lens. Fowler, S.A. and Allansmith, M.R. *Arch. Opthalmol.* 98(7): 1233-1236, July 1980.

The anterior surfaces of continuously worn therapeutic contact lenses and routinely cleaned cosmetic lenses were compared by scanning electron microscopy. The continuously worn lenses were uniformly and completely coated with material thicker and smoother than that on the incompletely coated cosmetic lenses. It is concluded that continuously worn lenses build up coatings steadily, whereas routinely cleaned lenses have at least part of the coating removed with each cleaning.

Author's Abstract.

The effect of cleaning soft contact lenses. A scanning electron microscopic study. Fowler, S.A. and Allansmith, M.R. *Arch. Ophthalmol.* 99(8): 1382-1386, Aug. 1981.

Scanning electron microscopy was used to investigate the effectiveness of surfactant and enzyme cleaners in removing coatings from soft contact lenses. We examined ten continuously worn lenses and 15 lenses worn and cleaned regularly for at least six months. About 30% of the surface of continuously worn lenses cleaned with surfactant or enzyme was uncoated; smooth, matted coating covered the remainder. Continuously worn lenses cleaned with the combination surfactant and enzyme cleaner had similar deposits covering 50% of the surface. Lenses worn and cleaned regularly had more deposits after cleaning with surfactant or enzyme than after cleaning with combination cleaner. Approximately 25% of the surface of lenses cleaned with the combination was coated with deposits. The deposits on both types of lenses were about 30% less thick after use of the combination cleaner than with either single cleaner. The coating on worn contact lenses is not completely removed by any method we tested.

Author's Abstract.

Clinical Implications

In a continuing attempt to understand the pathogenesis of giant papillary conjunctivitis, the authors in this series of papers examine the lens deposits, as these have been implicated in prior studies as containing the antigen responsibile for the conjunctival reaction. With the knowledge acquired from these studies of the evolution and tenacity of lens deposits, the clinician might consider stressing to the soft lens patient the following points:

1. Deposits start to form immediately.
2. Deposits, if left unchecked, can lead to complications which may force the end of contact lens wear.
3. No current regimen of lens cleaning assures a totally clean lens surface. (A common misconception by patients is that enzymatic cleaning at any interval restores the lens to its new condition.)
4. The front surface of a lens deserves particular attention in cleaning.
5. As some surface deposition is inevitable, and as some individuals seem predisposed to reactions to it, periodic professional examination of the tarsal conjunctival surface is necessary, particularly in the case of extended-wear lenses.
6. Periodic lens replacement may be necessary for the purpose of maintaining a clean lens on the eye.

Stark, W.J., Martin, N.F.: Extended-Wear Contact Lenses for Myopic Correction. *Arch. Ophthalmol.* 1981; 99: 1963-1966.

Clinical Implications:

The object of this study was to evaluate the long-term effects of extended wear lenses, particularly as an alternative to surgical correction of myopia. In this regard, the contact lenses are preferred by the authors.

However, the research provides information to make a comparison with a more readily available option, daily wear contact lenses. Some interesting data are:

- visual acuity less than 6/9 (20/30) in 20% of cases,
- rate of lens replacement 0.68 lenses per year per patient,
- average superior neovascularization 1.02+ 0.47 mm. compared to 0.39+ 0.13 mm. for myopic controls.
- 38% of patients lost to follow-up.

As no comparable data were collected for myopic daily wear contact lenses, no conclusions can be drawn. However, the authors caution against the indescriminate use of extended wear lenses for myopia, thereby expressing a preference for daily wear lenses where feasible.

Author's Abstract

The long-term effects of an extended-wear contact lens (perfilcon A [Permalens]) for myopia were evaluated in 106 patients who had successfully worn the lens for four to eight years (median, 4.94 years). Visual acuity was 6/12 (20/40) or better in 95% of the 207 eyes fitted. Corneal neovascularization, when encountered (8.7%), was mild and did not reduce visual acuity. There were no cases of infectious corneal ulcer or scarring or of permanent visual loss from use of the lens. In selected patients, use of extended-wear lenses seems to be a reasonable form of optical correction of myopia, and they deserve further study. The use of these lenses is discussed as an alternative to the experimental procedure of racial keratotomy.

Rennie, I.G., Parsons, M.A.: Lysozyme Distribution in Human Lacrimal Glands and Other Ocular Adnexa. *Arch. Ophthalmol.* 1981; 99: 1850-1853.

Clinical Implications

Richard Hill has described tear protein and specifically lysozyme as assuming the images of both benefactor and villain in contact lens practice: benefactor in the sense of acting germicidally and villain in the sense of lens spoilation.

The authors offer elegant proof of the origins of this dichotomous tear protein. This significant contribution to the knowledge of tear physiology is a step toward better understanding the interrelationships of the cornea, the tear film and the contact lens.

Author's Abstract

In an immunohistochemical study of the human lacrimal glands and other orbital adnexa, lysozyme was found to be present in the major and accessory lacrimal glands but absent from Meibomian glands and conjunctival epithelium. Almost all acinar and tubular cells in major and accessory lacrimal glands contain lysozyme, although occasional cells show diminished staining for lysozyme, probably because of secretion. Only one secretory lacrimal tubuloacinar cell type is demonstrable, although two types previously have been described. Lacrimal duct cells do not contain lysozyme. The findings of this study support the concept that the tubuloacinar cells of the main and accessory lacrimal glands are the sole source of the lysozyme secreted into tears.

Canadian Optometric Contact Lens Society Elects First Executive

l - r: Dr. Duncan Tennant, Treasurer; Dr. Joshua Josephson, President; Dr. Barbara Caffery, Secretary, on the occasion of the First General Meeting of the C.O.C.L.S.

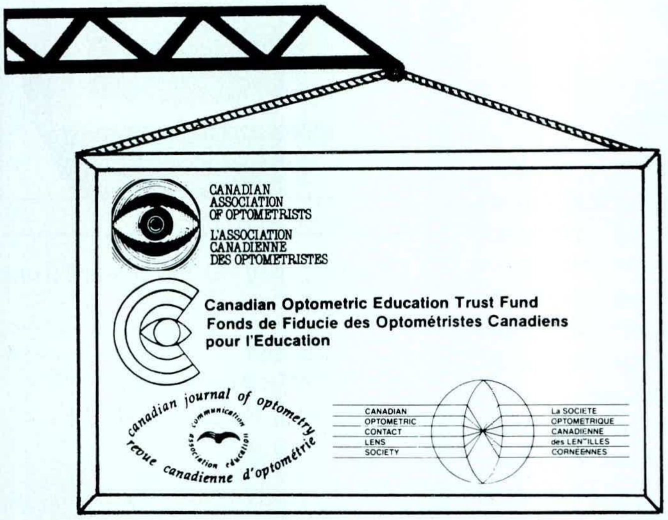
The First General Meeting of the C.O.C.L.S. was held October 9, 10 at the Hotel Ritz Carlton in Montreal. 25 members were present and they elected the following officers, who will serve as the Society's executive until its first Contact Lens Conference, tentatively planned for the spring of 1984:

President: Dr. Joshua Josephson,
Toronto, Ont.
Vice-President: Dr. Brian Goldberg,
Beaconsfield, P.Q.
Treasurer: Dr. Duncan Tennant,
Vancouver, B.C.
Secretary: Dr. Barbara Caffery,
Toronto, Ont.

In his remarks at the meeting, President Josephson emphasized that the goals of the Society were to be built around the need for a forum of information exchange to serve contact lens practitioners in Canada. This need, he said, will be met in many ways: through the Society's *Transactions*, now published as a regular part of the Canadian Journal of Optometry; through a national membership roster to enable easy referral of patients between C.O.C.L.S. members; and through a regular C.O.C.L.S. Conference, currently planned as a tri-ennial meeting.

In addition to the Executive, a full slate of committee appointments was made that will lead to the solidifying of the Society's structure in the months ahead.

Further information about the Society and its purpose, as well as membership information, can be obtained from: Michael J. DiCola, Administrative Program Co-ordinator, C.O.C.L.S., Ste. 2001, 210 Gladstone Avenue, Ottawa, Ontario, K2P 0Y6.



WE'RE MOVING!

After 10 years at our present address, C.A.O. is moving to a larger, more modern office, three blocks from Parliament Hill, in the nation's capital. **Effective January 1, 1983,** our new address will be:

Ste. 207 - 77 Metcalfe St.
Ottawa, Ontario
K1P 5L6

Our phone number remains the same:
613-238-2006

Vision Care Products

B-Vat Video Acuity Tester

The B-Vat acuity tester has been re-engineered and re-introduced as a system for fast, accurate acuity testing. Control buttons will change displays from single to multiple characters in size ranges from 6/3 to 6/120. This permits measurement of small changes in acuity, even in low vision patients.

Further information can be obtained from:

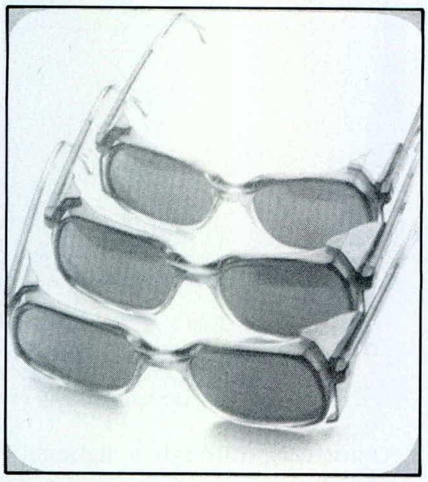
Mentor O & O Inc.
South Shore Park
Hingham, MA 02043
U.S.A.

CPF 550 Spectacles

As the name (Corning Photochromic Filter) suggests, these lenses are made from photochromic glass, with special filtering characteristics and unique photochromic behaviour. The function of the lens is to protect the rod receptors at all times and to permit visual perception by the cone receptors. The transmittance in bright sunlight is as little as 5% and indoors, fully faded, it increases to 21%. Throughout the photochromic cycle, 97% - 99% of the energy below 550 nanometers is occluded.

Although originally developed for Retinitis Pigmentosa patients, substantial benefits are experienced by patients with other ocular degenerative diseases.

The lenses are available in plano or prescription form and must be ordered directly from Corning Glass Works. There are two types of frames that can be used with the lenses.



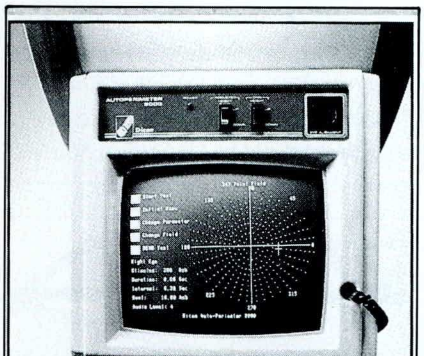
A trial kit has been assembled which can be purchased and used by professionals and institutions serving the partially sighted. Details regarding prices and direct ordering are available from:

Technical Products Division
Corning Medical Optics
MP21 - 2
Corning Glass Works
Corning NY 14831
U.S.A.

Dicon Autofield 2000

This autoperimeter is a sophisticated visual field instrument designed to provide rapid automatic screening and diagnosis. It is equipped with a CRT screen, with light control, which provides readouts and displays field defects simultaneously. There are 347 targets per eye and dense concentration in the pathologically significant areas. An exclusive feature called the Diagnostic Program allows the operator to sharply delineate the borders of a scotoma. Using the light pen, the region of interest is outlined and tested. Standard with the perimeter are 14 programs ranging from screening to precise definition. The plug-in memory module allows optional programs and future developments to be added at a later date.

The Auto Perimeter 2000



CRT screen with control console

Complete data can be obtained from:

Dicon
7356 Trade Street
San Diego, CA 92121
U.S.A.

The Canadian Optometric Education Trust Fund

Invites
Applications for Funding
under the awards schedule for the
1983 Grant Program

Purpose of the COETF

Recognizing the need to support the continuing growth and development of the profession of Optometry, the COETF is prepared to financially assist the educational, research and manpower programs deemed by the Trustees to be more important to achieving these goals.

Suitably trained optometric manpower, and the profession's continued access to that manpower is vital to our academic evolution. *The COETF supports* faculty development in our schools of optometry, graduate students in specialized educational programs and investigative research by undergraduate students.

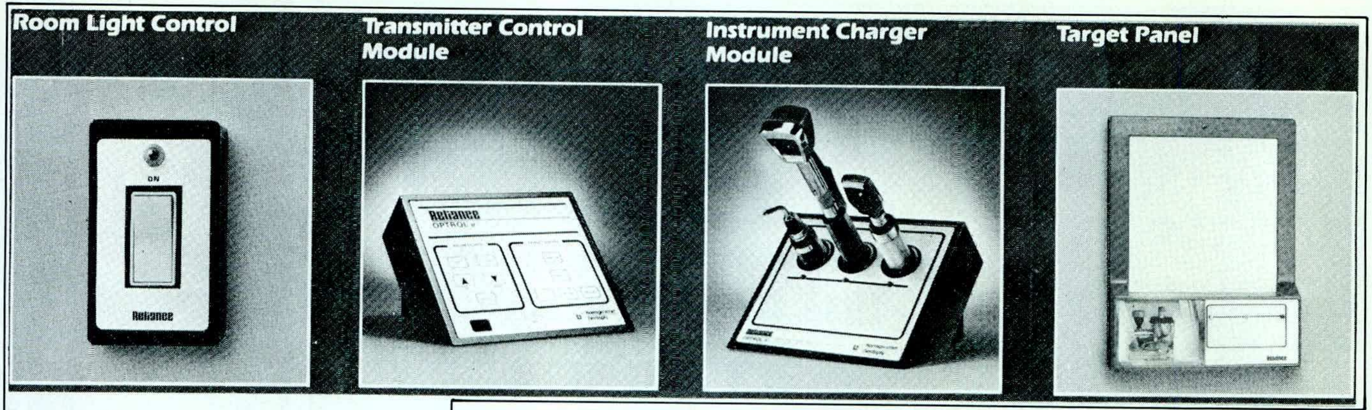
Ongoing research undertaken by the optometrist in private practice is just one type of professional development program which optometry must continue to initiate. *The COETF supports* projects established in a clinical environment to assist the visually handicapped and to assist other optometrists through preparation and publication of the details of these clinical research studies.

A third Canadian school of optometry is of vital concern to the profession. The ongoing activities of our two existing schools are just as important. *The COETF supports* needed alterations and renovations at both schools presently operating and stands ready to substantially assist in the operating cost support of a new school of optometry in Canada.

Continuing education in the 80s must be regular and structured as technology sweeps the profession forward into new methods and discoveries in the delivery of complete vision care. *The COETF supports* the development of an academic Chair of Physiological Optics and Continuing Education to meet these ongoing needs.

The Canadian Optometric Education Trust Fund invites your support in this "Vision of the Future". If you are (or know of) an optometric practitioner, student, educational institution, service organization or member of the general public who is presently involved in, or planning a program that meets any of the goals outlined above, then assistance might be available to achieve the project's objectives. Write to us, using the application in this issue by February 15, 1983. The Trustees assure that all projects meeting the purposes of the Fund will be given serious consideration.

The COETF supports!



Optrol II

The Optrol II system is a control system designed to enhance examination efficiency. It consists of four modular components, which allow manual and automatic control of incandescent room and target lights. The system is easily installed and may be integrated with your present equipment.

The Optrol II is a Reliance product, and information about it is available in Canada from Imperial Optical.

Canon CR2 - 45 NMA

Canc

mera which has easy focussing and working distance positioning and has a 45° angle of view. In addition to 35mm photography, Polaroid® photography is possible with an optional attachment. This enables photography of both eyes in less than five minutes. The 67mm image size allows the practitioner to visualize minute detail.

Further specifications are available from:

Canon Optics and Business Machines
Canada Ltd.
3245 American Drive

PhotoLite Plastic Lenses

PhotoLite lenses are a new photochromic plastic lens, the composition of which is a combination of CR - 39 impregnated with photochromic crystals. This material can be used as a "comfort" lens, not as a sunglass lens. It has a light transmission of 90% unactivated and activated 45%. In its unactivated state, it is clear and colourless; activated it has a bluish tint.

The lens was developed by American Optical and is distributed

Canadian Optometric Education Trust Fund
1983 Grant Program — Application for Funding

Complete and forward (we require 5 copies) no later than February 15, 1983, to:

COETF Grant Program,
Ste 2001-210 Gladstone Ave.,
OTTAWA, Ontario
K2P 0Y6

FULL NAME

MAILING ADDRESS

Tel. ( )

FUNDING CATEGORY .... ☑
Post Doctoral Study .... ☐
Clinical Research .... ☐
Undergraduate Research .... ☐
Public Vision Care
(conducted by non-academic
or non-practitioner) .... ☐

Title, nature and description of project

Expected date of completion

Expected benefit from project

Estimated Budget

Personal Services	Salaries	Equipment	Supply Mtl.	Travel	Tuition	Other (specify)
				Total Grant Requested $		

A formal written report will ☐ will not ☐ be a part of this study. (If yes, a copy must be submitted to the Trustees of the Fund and will be considered for publication in the Canadian Journal of Optometry. If no, a final summary and evaluation of the results of the project must be submitted to the Trustees of the Fund within 60 days of the completion of the project.)

SIGNED

DATE

BOOK REVIEWS

Ocular Immunology by Gilbert Smolin and G. Richard O'Connor, Lea & Febiger, Philadelphia, 1981, 322 pp, Illus., Cloth $33.00 (Canadian).

During the last decade, few areas of medical science have progressed as rapidly as immunology, particularly in the application of basic concepts to solving the problems of unresponsive disease processes. Smolin and O'Connor have endeavoured to summarize the recent advances, introduce the terminology associated with them and relate them to practical clinical problems. They have succeeded on all counts and the result is a readable, yet comprehensive, book which will enable the practitioner whose background is rudimentary in this field, or who has been unable to keep abreast with this topical subject, to update and enhance his knowledge.

A long and comprehensive introductory chapter, with little assumption of previous knowledge, guides the reader through the fascinating development of general immunological principles. Included are the nature of the immune reaction, inflammation and the five types of hypersensitivity reaction. Well-conceived, lucid schematic figures and flow diagrams enhance this section. The chapter concludes with the application of these basic concepts to the eye using the conjunctival and corneal responses as specific examples.

An overview of immunological testing procedures is provided with the caution that testing usually only confirms the category of an immunologic disease and rarely its cause. The authors emphasize that . . . "Blanket testing of individuals suffering from ocular inflammatory disease is both expensive and wasteful . . ." The subsequent five chapters of the book are devoted to the eye. Perusal of the section on atopic diseases affecting the eye will reward the reader with an insight into the developments that have occured since Coca introduced the term "atopy" (1923) to mean "strange reactivity" in those with allergic hereditary disease. However, despite all advances, avoidance of specific allergens remains the key recommended prophylactic measure. It is suggested that the giant papillary hypertrophy in the tarsal conjunctivae of some contact lens wearers is associated with either a personal or a family history of atopic disease.

Numerous immunologic reactions occuring either in the internal or external ocular tissues are discussed with the inclusion of pathogenesis, clinical manifestations and current opinions concerning treatment and therapeutic efficacy. Consideration of the role of infectious disease (bacterial, chlamydial, viral and mycotic) in immune-complex-mediated reactions supplements the more basic approach taken in general texts on eye disease.

Transplantation of living human tissue creates two major difficulties, one technical and the other related to the reactions of the host to the donor tissue. In their chapter on corneal graft reaction the authors describe the mechanisms of graft rejection and offer strategies for the corneal surgeon to prevent and treat rejection.

Each chapter is profusely referenced for the reader who wishes to delve even deeper into a particular aspect of the subject.

The most disappointing feature of this otherwise well-produced book is the less than excellent quality of many of the numerous black and white photographs. The poor resolution is particularly frustrating in the photographs of pathological preparations and those of the anterior segment. Two colour plates are also included but, unfortunately, much detail is lost due to insufficient magnification.

Notwithstanding these comments, this book provides an excellent update in this expanding field and would make a welcome addition to any optometrist's library.

A. Cullen

The Optometrist's and Ophthalmologist's Guide to Pilot's Vision. Warren V. DeHaan, O.D., The American Trend Publishing Company. Boulder, Colorado.

As an optometrist specializing in Aviation Vision, I have long recognized the need for a clinical manual in this field.

The examination of the pilot patient requires knowledge of the field of Aviation. The optometrist cannot use the same techniques in prescribing for the pilot that he uses for his earthbound patients.

The interested optometrist must have access to the regulations covering Aviation and Dr. DeHaan devotes 5 chapters to this. Although he deals exclusively with American regulations, Canadian regulations are quite similar.

The Canadian Optometrist can get our regulations by writing to Transport Canada, Air, Ottawa, Ontario, and requesting the Personnel Licensing Handbook.

Dr. DeHaan has chapters on visual acuity, empty field myopia, contact lenses and depth perception. All of these aspects of vision he relates to the flying environment.

His chapter on orthokeratology and Vision Improvement Methods are well thought out and presented in a logical way.

Chapters on frame selection and types of lenses most successfully used are excellent. This book allows the non-flying eye professional to understand some of the problems encountered by professional and private pilots and details how to deal with their specialized needs.

As more and more optometrists find themselves examining not only the private pilot, but also the Senior Commercial Captain, some knowledge of the field must be had. I heartily recommend that this book be a part of every optometrist's library.

Lorne G. Hart

Neuro-ophthalmology: clinical signs and symptoms, by Thomas J. Walsh, Lea & Febiger, Philadelphia, 1978, 285 pages + index.

The book is arranged in terms of signs and symptoms. Moreover, each short chapter provides a free-standing discussion of a topic, so the reader need not refer back and forth to many other chapters.

In order of size, the chapter headings are: retinal disease (related to neurological diseases), radiology, diplopia, field defects, headache, blurred vision, papilledema, exophthalmos, pupillary abnormalities, facial nerve paralysis, nystagmus, ptosis, and gaze.

There is a relative paucity of figures and diagrams, and few tables. One figure (a retinal photograph, Fig. 1-4) is turned 90 degrees. The lack of photographs is particularly troublesome in the chapter on diplopia.

The general tenor of the book is that of a highly specialized practitioner giving advice to a general practitioner. It is a very personal book, and the information is often anecdotal (I had five cases . . .): this is, of course, an entirely acceptable approach to a book, so long as the author's and the reader's biases agree. I found myself unhappy with the author's disinterest in any color vision tests aside from the HRR plates, some of his disparaging remarks about the Amsler grid, and his description of the duration of transient losses of vision.

In Walsh's experience, transient obscurations of vision which last from 5 to 15 seconds are due to increased intracranial pressure, while visual losses lasting 5 to 25 minutes (which he terms 'amaurosis fugax') are due to carotid artery disease. This does not agree with other authors, and Walsh does not provide any references to support his position. Personally, I would like to abolish the term 'amaurosis fugax' altogether, and use more descriptive terms like transient monocular blindness or transient binocular blindness.

A close reading of any chapter will uncover little nuggets of clinical wisdom such as the advice to test even a person who appears blind with some 20/20 letters: the person may have a very constricted field, which may not admit larger letters (such as 20/200 letters).

The chapter on retinal disease is mainly concerned with the phakomatoses (a group of congenital anomalies characterized by tumors based on astrocytes or by abnormal vascular overgrowths at the retinal, cranial, or facial level).

The chapter on headache is particularly well-written, and provides a brief but thorough review of all aspects of this vexing diagnostic problem.

As might be expected, the chapter on fields is excellent. One of the author's methods for studying disturbances of color perception in the visual field is to use a uniform orange poster board for testing, with a fixation point on the nasal side of the poster board. The patient then traces out with a pointer any areas where the orange color is missing or desaturated.

The chapter on blurred vision mentions several useful tests and many potential causes to be considered. Among the tests recommended in this chapter is the use of a neutral density 2 filter over an eye with reduced acuity: an eye with organic optic nerve disease will show a drastic reduction in acuity, while an amblyopic eye should show only 2 Snellen lines' decrease in acuity. Walsh also sugests use of the swinging flashlight test in any case of blurred vision (and in cases of suspected optic nerve disease or anisocoria).

In conclusion, this is a useful book, both as a review of problems primarily neurological and as an opportunity to profit from the clinical experience of a prominent neuro-ophthalmologist.

T. David Williams, O.D., M.S., Ph.D.
Associate Professor
School of Optometry
University of Waterloo

Contact Lens Design Tables, by Anthony Musset and Janet Stone, Butterworth and Co. Ltd. 1981, 154 pp.

This manual is directed toward a very specific problem — the problem of the clinician in specifying the peripheral curves of hard lenses. The entire written text occupies less than seven pages. The remainder consists of computer-generated tables for use in the selection of peripheral curve radii and widths for simple or sophisticated hard lens designs. The text deals with the use of the tables and provides the rationale for their development. Briefly the rationale follows.

Peripheral curves on hard lenses provide for a slight clearance of the peripheral zone of the lens from the corneal surface. It is generally agreed that this edge clearance serves several purposes:

(1) To provide a reservoir of tears at the edge of the lens available to flow beneath the lens during eye movement.
(2) To prevent epithelial damage from the edge of the moving lens.
(3) To support a tear meniscus at the edge of the lens which provides forces that tend to centre the lens.
(4) To permit easy removal of the lens.

This edge clearance is a function of the corneal topography and of a lens design parameter, edge lift. Although the exact topography of the cornea is seldom known, the edge lift of the contact lens can be varied to affect edge clearance from the cornea.

Recommended values for axial edge lift are given by the authors based upon the parameters of clinically successful lens designs. Furthermore it is implied that unless specific contraindications for an individual patient exist, axial edge lift should be constant for lenses of the same design. The tables provided allow the lens designer to easily calculate different series of intermediate and peripheral curve radii and widths which will result in equivalent axial edge lift. Suggestions are offered as to which characteristics of peripheral curve design may be most desirable.

These tables will be of use to the clinician interested in the detailed specification of his hard lenses, but lacking in the computer facilities or expertise necessary for their computation. Of course the use of either these tables or computer programmes is better than choosing arbitrary parameters and infinitely superior to accepting unknown standard laboratory parameters.

Brian Garnett, O.D.

Management of Low Vision.
by: Gerald F. Fonda.
Published by Thieme-Stratton Inc. New York George Thieme Verlag Stuttgard. New York, 1981, 248 pp. with illustrations.

This book offers the reader a comprehensive and well-organized approach to the management of the Low Vision patient. The author was formerly an Associate Clinical Professor of Ophthalmology at New York University School of Medicine and now is the Director of Low Vision Service at St. Barnabas Medical Centre. He deals with this topic in a very frank and direct way, injecting many clinical cases into a well classified system. He always ends each section by citing advantages and disadvantages of the visual aid categories. Throughout the text he rates different examination findings and disease entities which will determine the prognosis.

He begins with the examination and testing equipment which can easily be present in every optometric office. The author is very direct in discarding procedures and low vision aids which are not useful and a detailed emphasis is placed on those which are important. Some patient aids which are found least useful are Pinhole spectacles, telescopic units employing a contact lens as the ocular, hemianoptic spectacles, and field expanders. Emphasis instead is placed on a good refraction and then on "approach" magnification, paper weight and stand magnifiers, hand held magnifiers, high add bifocals and trifocals, half-eye spectacle magnifiers, and telescopic devices. Attention is paid to binocularity and the psychological well being of the patient.

A major goal of this text is to simplify the visual aids by initially trying the most successful and least expensive methods and then follow up by the more sophisticated techniques. For instance he discusses closed circuit television and its advantages but notes "it should not be recommended before a less expensive and portable device has been tried and evaluated, as they are indicated in less than one percent of patients." He also has some criticism for telescopic spectacles and their limited use. These aids reduce the visual field substantially and can create more of a handicap in some cases. In fact he feels driving with such devices is not practical. However good solid information about all the categories of aids, optical and non optical, along with the theoretical optics and preferred usage, is clearly outlined.

Sections on contact lenses, visual field defects, illumination, braille, reading type, colour vision defects and genetics, round out this text. Optometric references are used and it is interesting to note the predictable ophthalmological overview on some of the topics.

This is a good text for both students and clinicians, as a reference, a review and a guide.

Bruce N. Rosner, O.D.

Glaucoma, 2nd ed., by P.A. Chandler and W.M. Grant, Lea & Febiger, Philadelphia, 1979, 370 pages + index.

First published under the title, *Lectures on Glaucoma*, this book comprises 43 chapters, the bulk of which are by the senior authors: the balance of the chapters are contributed by 6 additional authors. The book consists of 4 parts: an introduction (20% of the book), diagnosis and treatment of glaucoma in adults (56%), surgical procedures and treatment of complications of surgery (10%), and diagnosis and treatment of glaucoma in childhood (14%).

The authors originally presented much of this material as lectures: I assume they must have used more diagrams and photographs in the lectures than in this book, because it contains only 16 black and white figures. In many instances, photographs illustrating some cases would make the book more useful clinically. On the other hand, one of the best features of the book stems from the nearly sixty years' combined clinical experience of the senior authors: they are able to illustrate their points with a total of 192 cases drawn from their experience (and that of the contributing authors). The bulk of the cases presented (86%) relate to glaucoma in adults.

Since the chapters are short (some as short as 1 page, but most around 10 pages), the practitioner has the opportunity to obtain a quick refresher on very specific topics, usually with a case report or two which will permit a comparison with a current case.

The authors demonstrate a refreshing pragmatism: they do not hesitate to point out cases which do *not* support old established notions (e.g. that myopes do not withstand open angle glaucoma very well, or that large cup/disc ratios carry a bad prognosis for glaucomatous patients). The authors offer valuable clinical insight into problems of glaucoma management: for example, when should treatment be started, how long can a healthy eye withstand elevated intraocular pressure, effects of topical steroids, and when to substitute surgical for medical treatment.

The introduction includes an excellent section on gonioscopy (30 pages), which includes many useful tables of normal and abnormal variations of angle structures.

Glaucomas in adults are covered under 24 different headings; thus, the reader may examine a very wide range of problems leading to glaucoma. These include, for example, exfoliation of the lens capsule, amyloidosis, and corticosteroids.

An interesting concept mentioned in the section on glaucoma surgery is that patients with filtering blebs should be instructed to apply digital pressure to their eye(s) several times daily, in order to ensure the continued patency of the new filtering channel: the amount of pressure is determined by the surgeon at the slit lamp. The correct amount of pressure is that which will cause a noticeable inflation of the bleb. This pressure is then taught to the patient.

The portion on diagnosis and treatment of glaucoma in childhood is all by David S. Walton: eleven chapters include much useful information concerning (for example) maximum acceptable corneal diameter (under 1 year, a diameter of 12 - 12.5 mm suggests abnormal corneal enlargement), examination under general anaesthesia, abnormal development of angle structures, (such as occurs in Marfan's or Rieger's syndrome), and the relation of lid hemangioma and glaucoma.

Reading this book is like having the opportunity of comparing clinical notes with a team of surgeons who deal exclusively with glaucoma: any practitioner (especially one with a problem patient on their hands) would welcome such an opportunity.

T.D. Williams, O.D., M.S., Ph.D.
Associate Professor
School of Optometry
University of Waterloo

Glaucoma Guidebook: by Gerald L. Portney Lea & Febiger, Philadelphia, 1977. 158 pp., illustrated.

This text accomplished its intention to provide a general overview of glaucoma. It emphasizes the basics of the disease, that is, an understanding of etiology, classification, clinical manifestations, diagnosis and treatment. It avoids the drudgery of exhaustive documentation yet does provide direction for more in-depth study if the reader so desires.

The introductory section, "Diagnosis and Therapy" outlines the basic classification of glaucoma. The essentials of patient management are stressed rather than disease mechanisms. It is interesting to note the authors preference in tonometry being the MacKay-Marg unit as well as his comments on the tangent screen as the most "useable of all devices" for visual field testing. The text does place emphasis on the various projection perimeters.

Portney brings us up to date concerning interpretation of early glaucomatous field defects. He emphasizes paracentral scotomas in the Bjerrum area, nasal step and asymmetric concentric contraction of the field as the earliest changes. He avoids reliance on enlargement or baring of the blind spot as an early sign. He notes factors that can affect field testing results and simulate glaucomatous changes. These factors are extreme miosis, refractive errors and media clouding.

The chapter on visual field changes in open angle glaucoma made a good attempt to explain these changes in a simplified manner. In order to demonstrate changes in the optic nerve head he introduces concepts of cone, cylinder and hemispheres in various combinations. This concept does become cumbersome but one is able to visualize the changes in this way. However, Portney made an important point that "colour alone is not a good guide for evaluating the progress of glaucoma" but rather "loss of nerve tissue" is the key here.

The medical management of open angle glaucoma is presented in a concise form that would be a good review for most optometrists. There is a good discussion on the factors in deciding whether or not surgery is advisable. The text provides an optometrist with background information on types of surgery that show up occasionally in daily practice.

The chapter on angle closure glaucoma involves a classic description and typical treatments for the disease. The final chapter covers the historical classification of glaucoma as a disease entity. It traces changes in the understanding of the principles of the disease over the last one hundred and fifty years. This makes one realize how much knowledge has been developed on glaucoma over such a short time.

There is concise glossary in the final section of the book. Portney's Glaucoma Guidebook would be a welcome addition to any optometrist's library. In 158 pages it presents glaucoma in a simplified manner worthwhile to any practitioner's understanding of the disease.

Stewart F. McLeod, O.D.

Depth Perception through Motion, M.L. Braunstein, Academic Press, New York, San Fransisco, New York, 1976, 200 pages, hard cover, illustrated.

As the title indicates, this is a specialty book in visual perception. Its chief aim is to show how various modes of motion can result in the perception of depth. The book presents a great number of studies in this field in a well organized and logical fashion. Much material which would otherwise be buried in highly specialized journals is thus brought alive and presented in perspective to a broader audience.

The book deals with the early discoveries of the effect of motion with respect to depth perception. It presents geometrical analyses of the moving retinal image and goes on to explain the illusions in terms of three-dimensional transformations. In addition, it deals thoroughly with the various aspects of slant perception and the perceived direction of rotary motion.

Interestingly enough, there is little or no concern with depth perception generated by binocular disparities; the material deals almost exclusively with monocular vision. Thus, there is no account of the well known Pulfrich stereophenomenon. This is not necessarily a shortcoming, but it does illustrate the extreme specialization of the book.

There are some minor flaws. The introductory chapter is very elementary and not always as precise as one might wish it to be. A case in point is the reference to Stratton and the statement that he was able to the inversion of the visual field. What Stratton actually experienced is, of course, highly controversial, and this should have been stated at least briefly. Whereas most of the diagrams are satisfactory, some of the drawings of subjects' heads are amateurish. Actually, this is a common flaw in books of this nature, and it is not clear why the talents of a professional artist could not be enlisted. Figure 4.13 is an example. Also, there is a problem with some of the lettering on the coordinate axes of the graphs; the letters are placed so close to each other that they run together when minified for publication purposes. However, mechanical flaws of this nature could have easily been corrected by the editor.

These very minor criticisms do not prevent the book from being a delightful piece of work, well worth owning for the optometrist who has an interest in vision beyond its immediate clinical aspects.

As a key hypothesis for explaining how depth perception is derived from motion, the author introduces the principle of heuristic processing. The term is widely applied in psychology, and psychologists would have no difficulty with this. However, if the book is directed to other scientific disciplines dealing with the visual process, the explanation of the concept is not entirely clear in spite of the illustrative examples. A reference to the Greek roots of the word heuristic would have been helpful, such as its original meaning: to find out, discover. Thus, depth perception due to motion, or any kind of perception for that matter, can be looked upon as a kind of problem solving process that usually, but not always, leads to the correct inference about the surroundings. When this process fails because of inadequate or distorted input, we experience illusions.

Finally, the book contains a chapter on computer animation and some suitable programmes for this purpose. This is obviously a useful tool for people engaged in vision research. However, with a bit of imagination, it appears possible that it could be used by an optometrist right in his office, as a visual training tool, for example.

Arnulf Remole, O.D., Ph.D.

"When your work speaks for itself, don't interrupt."
— Henry J. Kaiser

Professional Optical Company

P.O. BOX 691, STATION B
WILLOWDALE, ONTARIO
CANADA M2K 2P9

Canadian Journal of Optometry — Annual Index* Volume 44 — 1982

The Canadian Journal of Optometry gratefully acknowledges the support of all contributors and our advertisers.

ADVERTISER	TOTAL PAGES	ISSUE #
Academic Book Club	½	1, 2
Alcon Canada Inc. (Burton Parsons Division)	6	1, 2, 3
Allergan Inc.	4	1, 2, 3, 4
Barnes Hind Canada	6	1, 3, 4
Bernell Corporation	1	1, 2, 3, 4
Canadian Cancer Society	1	2
Canadian Optical Supply Company (1977) Limited	1	1
Carl Zeiss Canada Ltd/Ltée	7	1, 2, 3, 4
Centennial Optical Limited	¼	3
Ciba Vision Care Inc.	1	2
Essilor	6	3, 4
Hydron Canada	1	1
ICN Canada	1	4
Imperial Optical Canada	4	1, 2, 3, 4
Jena Instruments Ltd.	2	2, 3
K & W Optical Co. Limited	4	1, 2, 3, 4
Mercer Enterprises	Box Ad	1, 2, 3, 4
Nikon Canada Inc.	2	2, 4
Optica '82	½	1
Plastic Contact Lens Company (Canada) Ltd.	3	1, 2, 3
Professional Optical Company	1	1, 2, 3, 4
Quebec Optometric Association	1	2
ROI Management Inc.	Box Ad	4
Susan Rosner Interior Design	1	1, 2
Syntex Ophthalmics Inc.	4	4
Union Optics Corp. (Canada) Ltd.	4	1, 2, 3, 4

EDITORIALS

Belanger, G.M.:	Fact and Fantasy in Advertising	No. 2, p. 66
	Multifocals and Progressives; Alternative not Superiority	No. 2, p. 67
	Market Surveys	No. 4, p. 159
Williams, T.D.:	Problems with Automated Field Testing	No. 1, p. 4

ARTICLES

Alloucherie, Y.	Retinal Photography Without Mydriatics	No. 4, p. 190
Backman, H.A.	The Effect of Deposits on the Eye	No. 4, p. 194
Bear, J.C.	Why Can't We Explain Refractive Error?	No. 4, p. 179
Belanger, G.M.	An Amblyopia That Wasn't	No. 2, p. 82
Charman, W.N.	Gradient-index Optics	No. 4, p. 164
Dalziel, C.C.	Vision Training for N.H.L. Goaltender, Rogatien Vachon	No. 2, p. 86
Egan, D.J.	The Application of Selected Broadband Red Filters for Red-Green Deficiencies	No. 1, p. 50
Hensel, G.	Cycloplegic vs. Manifest Refractions	No. 2, p. 99
Janoff, L.E.	The Effect of Freeze/Thaw Conditions on Hydrogel Lens Posterior Apical Radius and Surface Quality	No. 4, p. 192
Jose, R.T.; Browning, R.A.; Brilliant, R.L.	Low Vision in Primary Care Optometry	No. 2, p. 76
Lapierre, N.	Diagnosis of a Double Hyperphoria	No. 2, p. 96
	Simplification of the Bielchowsky head tilt test for the general practitioner	No. 2, p. 97
Larson, W.L.; Giroux, R.	A Precision Instrument for the Clinical Measurement of Stereoscopic Acuity	No. 2, p. 100
Pace, R.	Noncomitant Ocular Deviation	No. 2, p. 93
Rudkin, S.W.	Low Vision Care in Canada: The Quebec Perspective	No. 1, p. 11
Salmon, D.	Helping Low Vision Patients to Read Again	No. 2, p. 74
Sevigny, J.	The Binocular Status of Two Mono-Vision Patients	No. 3, p. 137
Simonet, P.	L'Evaluation de l'acuité visuelle chez le handicape visuel	No. 1, p. 13
Sivak, J.G.	The Contribution of the Crystalline Lens to the Chromatic and Spherical Aberrations of the Eye	No. 2, p. 89
Spearman, E.J.; Rathgeber, A.J.	St. Vital Vision Screening Study	No. 2, p. 70
Strong, J.G.	Radical Retinoscopy in the Low Vision Examination	No. 1, p. 22
Strong, J.G.; Sivak, J.G.	Simple Clinical Photokeratoscopy	No. 1, p. 28
Williams, T.D.	Reflections from the Retinal Surface: Some Clinical Implications	No. 1, p. 25
Woo, G.C.	Contrast Sensitivity Function and Low Vision	No. 1, p. 46

FEATURES/ANNOUNCEMENTS

AOA Counsel Tom Eichhorst Visits U. de M. School of Optometry	No. 1 p. 8
B.C.O.A. Contact Lens Wearer's I.D. Card	No. 1, p. 29
Canadian Optometric Contact Lens Society Elects First Executive	No. 4, p. 197
Canadian Optometric Education Trust Fund 1982 Awards Total $60,000!	No. 3, p. 142
CAO Annual Report 1981	No. 1, p. 32
CAO Traffic Light Visibility Survey	No. 2, p. 69
Congratulations to School of Optometry University of Waterloo 1982 Graduates	No. 4, p. 159
Contact Lens Abstracts	No. 4, p. 196
Dr. Roland des Groseilliers New C.A.O. President	No. 4, p. 160
Felicitations aux Nouveaux Docteurs de la Promotion de l'Ecole d'Optométrie de l'Université de Montreal, 1981	No. 1, p. 18
Montreal Association for the Blind Low Vision Clinic	No. 1, p. 12
New Associate Editor for Vision Care Products	No. 4, p. 199
New Optometric Institute of Toronto Looks to Future	No. 2, p. 81
Nova Scotia Association Honours Dr. John Mulrooney	No. 4, p. 161
Profiles in History: An Interview with E.J. (Ted) Fisher	No. 4, p. 173
Vision Care Products	No. 2, p. 105 No. 3, p. 141 No. 4, p. 198

BOOK REVIEWS

Contact Lens Design Tables	No. 4, p. 203
Contact Lenses, Volume II	No. 1, p. 59
Cosmetic Contact Lenses and Artificial Eyes	No. 1, p. 58
Depth Perception through Motion	No. 4, p. 204
Essential Ophthalmology	No. 1, p. 58
Glaucoma, 2nd Edition	No. 4, p. 203
Glaucoma Guidebook	No. 4, p. 204
Handbook of Orthoptic Principles	No. 1, p. 59
Management of Low Vision	No. 4, p. 203
Neuro-Ophthalmology: Clinical Signs and Symptoms	No. 4, p. 202
Ocular Immunology	No. 4, p. 202
The Optometrist's and Ophthalmologist's Guide to Pilot's Vision	No. 4, p. 202
Sports Vision	No. 1, p. 59

***NOTE: Volume 44, No. 3 was a Special Feature Edition devoted entirely in tribute to retiring professors Drs. Fisher, Bobier and Lyle. Section titles in this issue were: A Pause in the Long Road of Progress; Unseen but not Unsung; Builders They Were All; A Reminiscence of Three Wise Men; Many Tributes from Their Many Peers; A C.J.O. Interview: Sharing 1¼ Centuries of Experience!**


POLYCON®
II
IS HERE!

SYNTEX

SYNTEX OPHTHALMICS, INC.
P.O. BOX 39600
PHOENIX, ARIZONA 85069-9982

IN CANADA:
SYNTEX, INC.
2100 SYNTEX COURT
MISSISSAUGA, ONTARIO L5M 2B3

THE PROVEN LENS HAS BEEN IMPROVED.

IMPROVED WITH TINT

POLYCON has long been the leading gas permeable rigid lens, depended upon by more than 13,000 practitioners. And now a remarkable second generation lens, POLYCON II, is here. First you will notice the tint. Just enough blue tint to make POLYCON II easy to find, in and out of the case. And easy to handle. New fits as well as previous PMMA wearers will appreciate this element of convenience.

IMPROVED WETTABILITY

The new POLYCON II lens has a wetting angle of 15 degrees, significantly lower than the 22 degrees common to standard PMMA lenses. That's why POLYCON II lenses will wet far more easily and evenly over the entire lens surface. That's why, when combined with our new increased permeability, patients should experience faster adaption, greater comfort and noticeably longer wearing time with POLYCON II.

IMPROVED PERMEABILITY

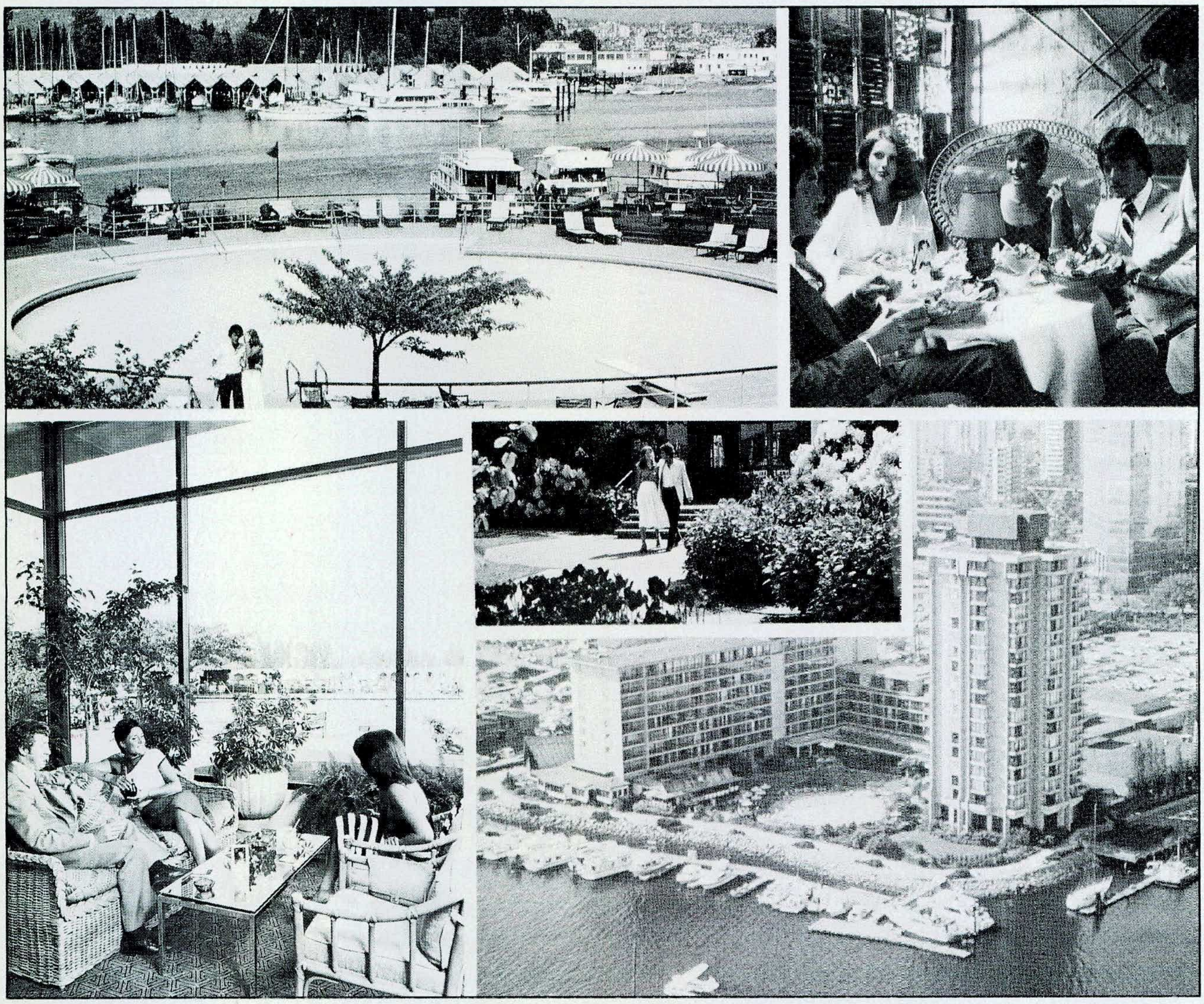
The new POLYCON II lens features an impressive DK of 12. This unusually high permeability combined with our proven thin lens designs results in the highest degree of oxygen transmission to the cornea of any approved rigid lens.

The new optimum in total visual performance...POLYCON II is here!

POLYCON® II
(silafocon A) GAS PERMEABLE LENS

For more information call toll-free 800-268-3964,
Toronto 821-7070 . Or write to Syntex.

C.A.O. Congress - July 1983
You're invited to
PACIFIC PARADISE
right here on Canada's West Coast



The 1983 C.A.O. 18th Biennial Congress is being hosted by the British Columbia Optometric Association in scenic **Vancouver, July 5-8, 1983** at the beautiful Bayshore Inn. Why not schedule a few days in Canada's "Pacific Paradise"?

Plan NOW to Attend!

★9 HOURS OF EXCELLENT LECTURES:

- Dr. W. Lyle, Professor, School of Optometry, U. of Waterloo, "The Use of Drugs in Optometric Offices."
- Dr. Ken Polse, Professor, School of Optometry, U. of California (Berkeley), "Contact Lenses."
- Dr. Ian Bailey, Professor, School of Optometry, U. of California (Berkeley) and John Jantzi, O.D., M.Sc., Diplomate, Low Vision, Vancouver, B.C., "Low Vision."

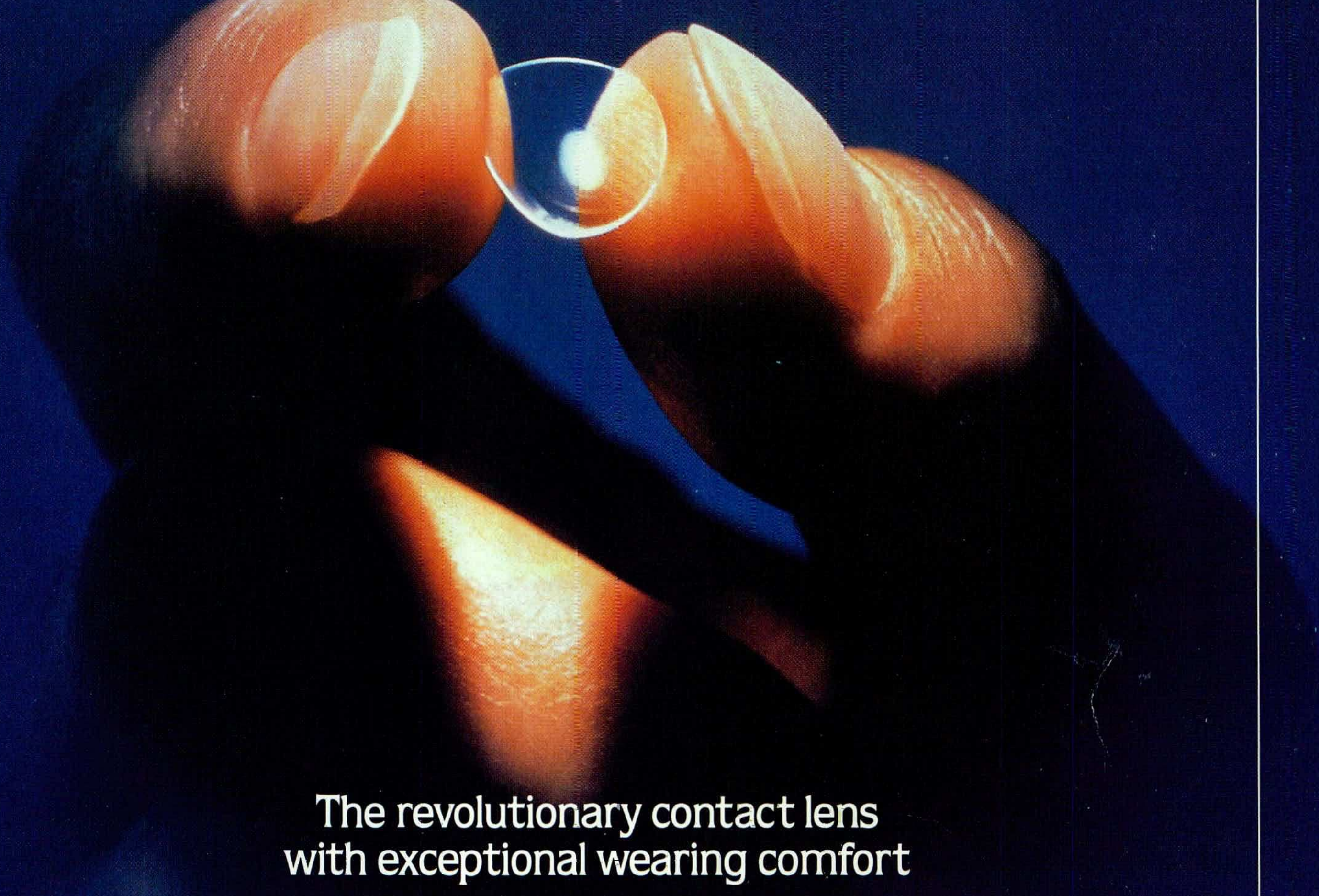
★LARGE EXHIBITION OF MODERN OPHTHALMIC EQUIPMENT

★EXCITING SOCIAL PROGRAM:

- Sunset Cruise and Dance on 500-passenger sailing vessel BRITANNIA.
- President's Banquet and Royal Hawaiian Floorshow.
- Spouses' Tour of the North Vancouver Mountains in a Steam Locomotive.
- Complete, Supervised Professional Children's Program.

★Holiday Tours to B.C. and Alaska

conflex



The revolutionary contact lens with exceptional wearing comfort

Introducing CONFLEX, the flexible gas-permeable contact lens with all the advantages of a conventional hard lens plus exceptional wearing comfort right from the start. Consider these features:

• Short wearing-in time • Flexible yet firm lens • Corneal astigmatism correction • Excellent durability • Easy to handle • Oxygen permeable • Exceptional initial comfort

For the practitioner Zeiss offers an outstanding service program, including an exclusive fitting kit, a generous per-case plan, and fast shipment of lenses, normally from stock. And, of course, CONFLEX lenses mean happier wearers.

CONFLEX lenses are made of the proprietary new material ANDURAN from BAYER West Germany.

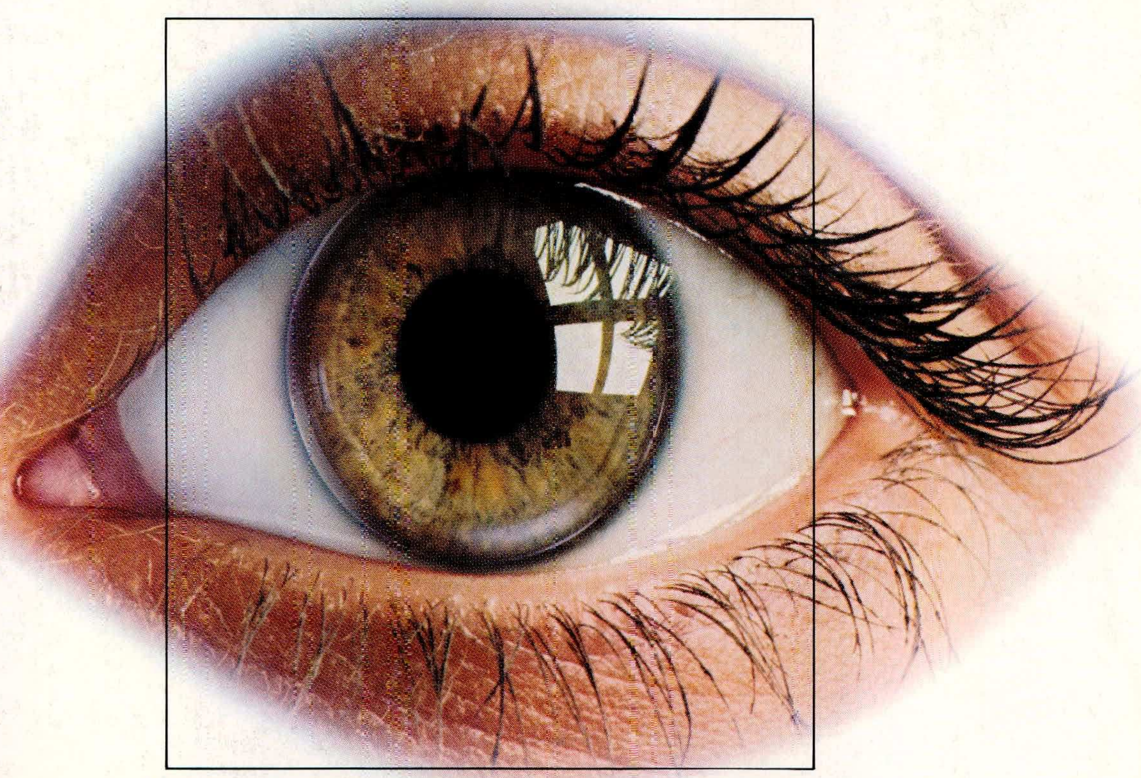
ZEISS

West Germany

Carl Zeiss Canada Ltd/Ltée (416) 449-4660

HYDROCARE®

The complete soft lens care system...



that prevents protein build-up

Hydrocare® Protein Remover Tablets

Weekly use of these tablets containing stabilized papain removes and prevents build-up of protein and diminishes the frequency of inorganic films. Starter Pack: 12 tablets with mixing vials. Refill Pack: 24 tablets.

Allergan Preserved Saline Solution

A sterile, buffered, isotonic solution for daily rinsing and heat disinfection.

Hydrocare® Cleaning/ Soaking Solution

Daily use of this sterile, preserved, buffered, isotonic solution hydrates, disinfects and removes oily contaminants with one solution.

Allergan
Allergan
Allergan
Allergan
Allergan

Allergan
Allergan
Allergan
Allergan
Allergan

ALLERGAN
Allergan Inc.
Pointe Claire, Que.

MEMBER
PMAC