

CJO RCO

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IN THIS ISSUE: CAO's Brief to the House Committee on Health and Welfare

CH-INCLUS : Mémoire de l'ACO au Comité de la santé nationale et du bien-être social

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**POLITICAL ACTION
VICTORY**



Minister of Finance Finally Approves Optometric Certification of Blindness as Disability for Tax Purposes



CAO has achieved a long-awaited and much sought victory in one battle in our program of national political action.

Michael H. Wilson, Minister of Finance, has finally agreed that Doctors of Optometry are capable and qualified to certify — for tax purposes — blindness as a disability. Following is the complete text of a letter received by CAO late this summer:

This letter is in response to your representations to permit licensed optometrists to certify sight-impaired individuals as "disabled" for tax purposes. Accordingly, I would like to advise you that licensed optometrists will be allowed to certify "severe and prolonged" sight impairments, effective for the 1988 and subsequent tax years.

For a sight impairment to be considered "severe", the individual must have visual acuity of 20/200 (6/60) or less after correction in the best eye, or 20 degrees or less of peripheral visual field in the best eye, after correction. For a severe sight impairment to be considered "prolonged", it must last, or be expected to last, continually for a period of at least twelve consecutive months.

I would appreciate it if you would communicate these guidelines to all licensed optometrists. It should also be noted that if a licensed optometrist has a question about a particular patient, the Department of National Health and Welfare has provided an advisory service (for doctors only) that can be reached toll-free at 1-800-267-6567/6568.

The Income Tax Act and the Disability Certificate (Form T-2201) will be amended at the earliest opportune time to reflect this change.

Yours sincerely,

Michael H. Wilson
Minister of Finance

FOOTNOTE: The amendments to the Income Tax Act, contained in Bill C-139 and which include direct reference to the optometrist as an "appropriately qualified person" where the impairment "is an impairment of sight", received Royal Assent on September 13, 1988. It is now official! (Editor)

**L'ACTION POLITIQUE,
C'EST EFFICACE**



**Le ministre des Finances approuve enfin la validité
de l'attestation de cécité donnée par un optométriste,
en termes d'incapacité aux fins de la Loi de l'impôt.**



L'ACO a obtenu une victoire longtemps attendue et âprement disputée, dans son programme national d'action politique.

Le ministre des Finances, M. Michael H. Wilson, a enfin convenu que les docteurs en optométrie sont habilités et qualifiés pour attester, aux fins de la Loi de l'impôt, la cécité en tant qu'invalidité. Voici le texte intégral de la lettre reçue par l'ACO à la fin de l'été :

La présente est une réponse à vos représentations visant à permettre aux optométristes titulaires d'un permis d'attester l'invalidité, aux fins de l'impôt, des personnes affligées d'un handicap visuel. En conséquence, je vous informe que les optométristes titulaires de permis pourront attester les handicaps visuels « graves et prolongés », et que cette mesure entre en vigueur pour l'année fiscale 1988 et les années subséquentes.

Pour que le handicap visuel soit considéré comme « grave », l'acuité visuelle de la personne ne doit pas dépasser 20/200 (6/60), après correction de l'oeil le meilleur, ou 20 ° ou moins de vision périphérique dans l'oeil le meilleur, après correction. Pour qu'un handicap visuel grave soit « prolongé », il doit durer, du moins hypothétiquement, de façon constante au moins 12 mois consécutifs.

Je vous saurais gré de bien vouloir communiquer ces directives à tous les optométristes titulaires de permis. J'ajoute que si un optométriste a des questions à poser au sujet d'un malade en particulier, le ministère de la Santé nationale et du Bien-être social a un service consultatif (réservé aux médecins) qu'on peut rejoindre sans frais au numéro 1-800-267-6567/6568.

La Loi de l'impôt sur le revenu et le certificat d'incapacité (formule T-2201) seront modifiés dès que possible en ce sens.

Veuillez agréer, Monsieur, l'expression de mes sentiments les meilleurs.

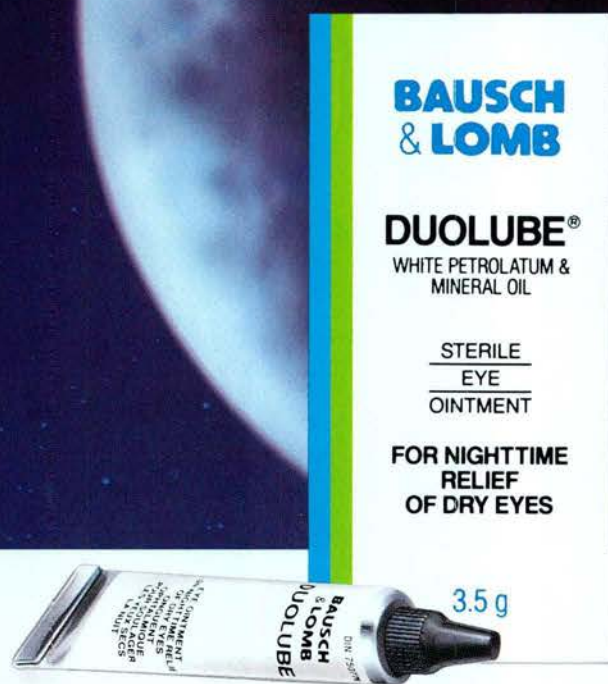
Le ministre des Finances,

Michael H. Wilson

REMARQUE : Les modifications à la Loi de l'impôt sur le revenu, contenues dans le projet de loi C-139 et faisant mention expresse de l'optométriste en tant que « personne dûment qualifiée » dans le cas d'un « handicap visuel » ont reçu la sanction royale le 13 septembre 1988. C'est donc officiel! (Note de la rédaction)

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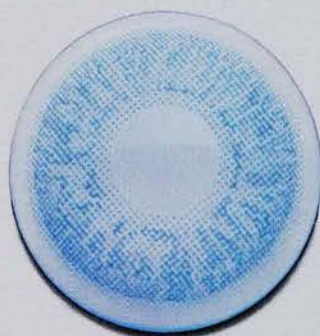
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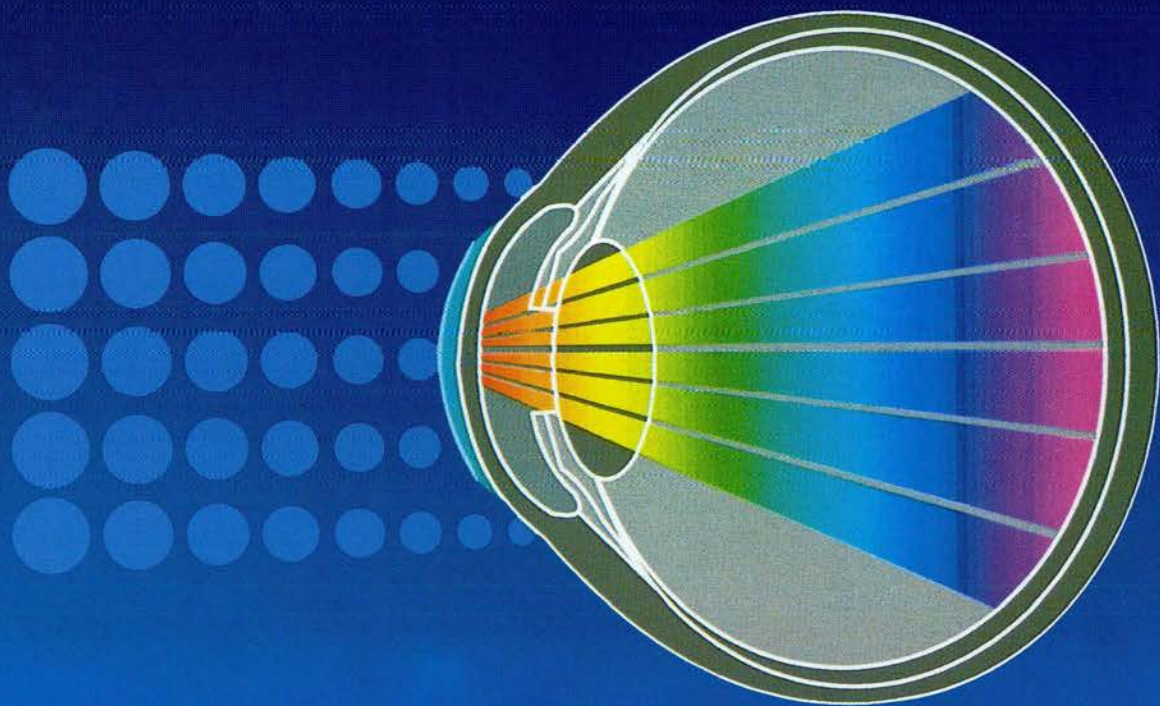
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COVER / EN COUVERTURE

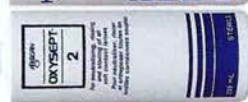
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References 1. Multi-Center Study, Comfort Evaluation of Hypotears vs. Tears Naturale II. Abelson, M.B., Eye Research Institute, Boston, Massachusetts, 1987. 2. Application of Lacrimal Scintigraphy to the Development of Ophthalmic Formulations, Olejnik, O., et al. Monograph, Queens Medical Centre, Nottingham, England, 1987.

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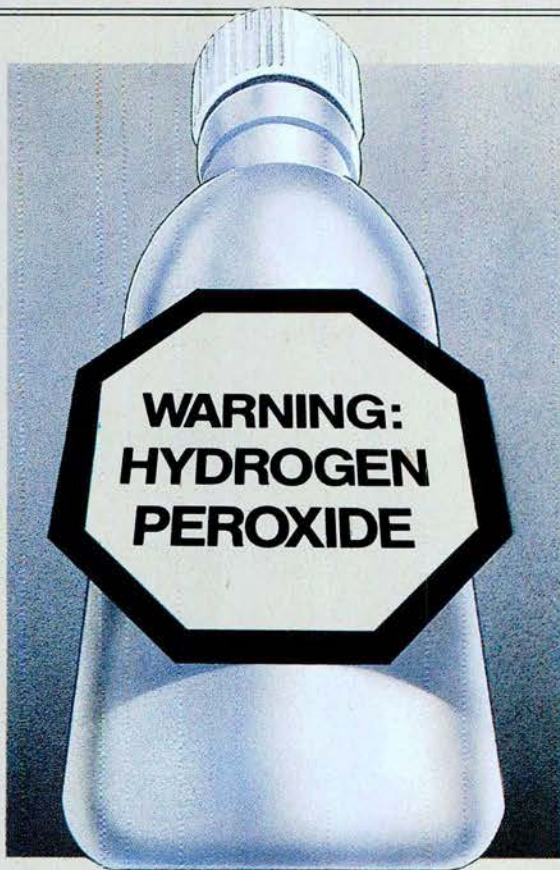
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– Studies have demonstrated definitively with rabbits that hydrogen peroxide is highly toxic to the endothelium, and that long-term damage can occur.^{1,2} "Levels as low as 2 ppm caused immediate severe swelling in isolated rabbit corneas."² The concentration currently being used for lens disinfection is 30,000 ppm.

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1. Kersley JH. (Chairman) Contact lens care into the future. Highlights of a roundtable discussion. Core communications, Toronto, Ontario. 1987. 2. Gyulai P. Relative neutralization ability of six hydrogen peroxide disinfection systems. *Contact Lens Spectrum*. p. 62-68, May 1987. 3. Data on File. Alcon Canada Inc. Mississauga, Ontario. 4. Parker JH. The influence of material structure upon C.L. cleaning. *Contact Lens Forum*. p. 27-44, June 1983.

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PRESIDENT'S PODIUM / MOT DU PRÉSIDENT

(Continue to) Be Part of the Solution!

...because, as the old adage goes, the alternative is to be a part of the problem.

And in all the years of political action by optometrists in Canada, we as professionals can state proudly and unequivocally that we have always been part of, and contributed to, solutions and resolutions in the ongoing challenge of delivering health care to Canadians.

The Medicare Act in 1967, The Canada Health Act in 1984 and, most recently, Bills restricting the advertising of tobacco have all been unquestionably strengthened by the support this profession has provided in the course of their passage through the legislative mazes of federal politics.

As you read this, depending on Canada Post's Second Class Mail Delivery system the 1988 Canadian Federal election is either just about to happen, or has just happened. In either instance, the bulk of your work in support of a particular candidate is probably complete and, like most Canadians, you are beginning to ponder the implications of the results.

My purpose in writing to you in this issue is to urge each and every one of you to continue to participate in Canadian federal politics in an active and direct manner. The issues facing Optometry are as varied as the national spectrum which elects 295 Members of Parliament and, in the months ahead, you will be receiving information about these issues, and CAO's desired position with respect to them.

You will also soon receive a Phase II Political Action Program questionnaire, whose results will enable us at the national office to target specific politicians on specific issues through specific optometrists across Canada.

If the election results produce a strong tie between you and a particular Member of Parliament, tell us. We want to know, and quite frankly, we need to know. 1988 begins a new session in Canadian Federal politics and the results of our continued participation in the process are exactly as good as the strengths of those optometrists we can field on any given issue.

When – shortly after the election – the questionnaire arrives in your mail, please read it, complete it and return it to CAO.

Join us. Be a part of the process. Be a part of the solution!

Dr. T. L. Adamack, President

(Continuez à) faire partie de la solution!

...car autrement, comme le dit le vieil adage, vous ferez partie du problème.

Et depuis les nombreuses années d'action politique menée par les optométristes canadiens, nous pouvons affirmer fièrement et sans équivoque que nous avons contribué aux solutions au défi permanent que représente l'administration des soins de santé aux Canadiens.

La Loi sur les soins médicaux en 1967, la Loi canadienne sur la santé en 1984 et, tout récemment, les projets de loi limitant la publicité du tabac, voilà autant de mesures qui ont, sans conteste, profité de l'appui que notre profession leur a donné lors de leur passage par le labyrinthe législatif de la politique fédérale.

Au moment où vous lirez ces lignes, selon l'efficacité du système de livraison du courrier de la deuxième classe de la Société canadienne des postes, les élections fédérales canadiennes 1988 sont sur le point d'avoir lieu ou viennent tout juste d'avoir lieu. Dans l'un et l'autre cas, vous avez probablement terminé le gros de votre travail pour un candidat particulier et, comme la plupart des Canadiens, vous commencez à soupeser les conséquences des résultats.

Je voudrais profiter de ce numéro de la Revue pour inviter chacun et chacune d'entre vous à continuer de jouer un rôle actif et direct dans la politique fédérale canadienne. Les thèmes qui intéressent l'optométrie sont aussi variés que les intérêts nationaux qui élisent 295 députés; dans les mois à venir, vous recevrez des renseignements sur ces thèmes, et sur la position que souhaite prendre l'ACO à leur sujet.

Vous recevrez également sous peu un questionnaire de deuxième volet du Programme d'action politique, dont les résultats permettront au Bureau national de cibler des élus particuliers sur des questions particulières par le truchement d'optométristes particuliers.

Si les résultats des élections produisent un lien solide entre vous et un député quelconque, dites-le nous. Nous voulons savoir et, à vrai dire, nous devons savoir. L'année 1988 est le début d'une nouvelle session de la politique fédérale canadienne et les résultats de notre participation soutenue au processus seront aussi bons, ni plus ni moins, que les forces des optométristes que nous saurons mobiliser sur une question particulière.

Lorsque – peu après les élections – le questionnaire vous parviendra dans le courrier, veuillez le lire, le remplir et le renvoyer à l'ACO.

Soyez des nôtres. Faites partie du processus. Faites partie de la solution!

Le président, Dr T. L. Adamack

Fred Nuttall (1900-1988)

The death of Fred Nuttall brings to mind once again the tremendous debt which present day optometrists owe to those pioneers who sacrificed so very much of their personal time and fortune very freely, in order that Optometry might reach its present level of success and public recognition. Many present day optometrists may ask "Who was Fred Nuttall anyway?" Let me try to fill in some of the strides Optometry has taken because of Fred Nuttall and others of his generation.

Fred Nuttall was born in Bury, in Sussex, England in 1900. Canadian optometry has always been indebted heavily to the fact that many of its pioneers came from England, and Fred Nuttall is more than a typical example. He was the youngest of five children of an English steamfitter. Fred was a very studious child and achieved academic distinction by winning the George V Medal as the top boy scholar in all of London in 1911 – no mean accomplishment. This entitled him to a scholarship at an "upper class" school for boys. Now one must recall the rigid class system which was found in England during the early years of this century. The prospective life of a boy from the tradesman class in an upper class school among sons of noblemen would have been sheer misery. Recognizing this, his father decided to move the family to the promising and democratic colony of Canada. They were scheduled to sail at the same time as the *Titanic*, but due to a delay in the coal delivery to the latter, the fuel required was diverted from their ship to the *Titanic* and the sailing date was delayed by one week until more coal could be obtained.

Fred Nuttall's family arrived in Canada and proceeded to Calgary which at that time was a bustling small town on the "wild west" frontier. At an early age Fred became an apprentice watchmaker with D.E. Black and Sons, which was later taken over by Birk's Jewellers. He acquired considerable skill in watch repairing so that the famed Father Lacombe used to travel to



Calgary and insist that Fred alone must repair his watch! As an avocation, Fred played the clarinet in the Calgary symphony in its early days. In the course of his work in the jewellery store, as was common 70 years ago, he became interested in Optometry and studied to become an Optometrist. By 1923, he had opened his own practice in Lethbridge, and continued in it until his retirement in 1973.

As one who had an all-embracing interest in this new profession which cared for the vision of so many people, Fred Nuttall responded to the need for leaders who would give direction to the emerging profession of Optometry. He became active in the very early days of the Alberta Optometric Association, and assumed executive and leadership positions. He was appointed the Alberta representative to the re-vitalized Canadian Association of Optometrists in 1940. As a point of interest unknown to many present optometrists, there was an association of the same name in 1908, but it was not truly representative. Other

attempts were made to revive a national association in the 1920's, but success wasn't achieved until 1940, and Fred Nuttall played an important part in making that organization what it is today. He was elected the fourth president of CAO in the years 1948-1949. In the capacity of President, Fred served capably and made significant contributions to Optometry's development. It was during his years as president that the federal charter of the Canadian Association of Optometrists was obtained. Also, the first general meeting of the Association occurred in his final year of office. In his own quiet soft-spoken and witty way, he worked diligently for the advancement of Optometry at the national level.

Following his retirement from active practice in 1973, Fred maintained a lively interest in the progress of Optometry, although he was suffering from some of the typical problems which afflict older people. Five years ago he underwent successful cataract surgery, and in 1984 moved nearer to his daughter in Drayton Valley where his wife was admitted to a nursing home. He maintained his lively interest in Optometry, constantly surprised by the significant advances made in the world of eye care, and humbly proud of the role he had played in both private practice and in the provincial and national associations. His friends called him "the grand old man of Optometry" and indeed the title was well deserved.

Fred died on April 23, 1988. He is survived by his widow, daughter Barbara Byrne, four grandchildren, one great-grandchild and a brother. Canadian optometry is the richer for having numbered among its distinguished leaders and CAO past-presidents this outstanding English-born optometrist. Rest well, Fred. Your contributions to Canadian optometry will not be forgotten!

**Edward J. Fisher,
M.A., D.Sc., F.A.A.O.**



EDITORIAL/ÉDITORIAL

LOSS BY DEFAULT?

The following text would probably better be suited to the Book Review Section of this issue, motivated as it is by the recent publication of *Vision Therapy in the Primary Care Practice* by Drs. Jerome and Joy Rosner. The subject of this commentary, however, is serious enough to justify an editorial.

Even a cursory overview of the curriculum of any School of Optometry shows that Binocular Vision still takes up a significant portion of didactic and clinical programmes offered at the undergraduate level.

It has been a justifiably consistent claim of this profession to state the optometrists are trained to offer the full spectrum of vision and eye care services, services which include Vision Training — whether it be called that, or Orthoptics or Vision Therapy.

Why then, we wonder, do so few optometrists really and truly manifest an interest in this aspect of practice, or actually apply it on a regular, clinical basis?

There are many explanations offered for this situation, both from a public perspective and from that of a practitioner. We hear, for example, of public ignorance of the value and usefulness of Vision Therapy (a wonderful reason, to be sure, but a sad excuse.) Or we are conveyed the impression by colleagues that Vision Therapy is time consuming and not very remunerative. But are these the real reasons?

Unquestionably, the key to the successful practice of Vision Therapy is confidence by the practitioner in both the value and the efficacy of its prescribed procedures, a process which must be instilled from the moment we began learning its specifics.

So, we ask, do our educators and our political leaders — to whom students and new graduates respectively look for guidance — put sufficient importance on the value, the usefulness and the clinical application of Vision Therapy? Or are we all so taken up with contact lenses and recognition of disease to weigh Vision Therapy's significance? It is an Editor's prerogative to interpret a situation broadly and, on the subject of VT, this Editor unabashedly feels that, over the longer term, it could well prove to be the salvation of many optometric offices, if not that of the profession itself.

The teaching — indeed, the learning — of Vision Therapy demands enthusiasm, conviction and perseverance on the part of the professor, not to mention basic professional competence. We have no doubt whatsoever that our current teaching personnel possess the latter. But we sometimes question the presence of the former — enthusiasm — given the evidence of so little of it in the vast majority of new graduates — little enthusiasm, that is, for Vision Training.

Undeniably, a huge portion of optometric services falls under the prescribing and supplying of optical devices. And it is precisely in this area that commercialism, with all its inherent risks to professionalism, rears its merchandising and marketing focussed heads. None of today's chains would continue to exist for very long if their activities were not linked directly to the supplying of materials.

In this consumer-oriented society and era of growing deregulation, the threat — we would go so far as to say the reality — exists

that purely commercial interests view professional services simply as one more block of commodities to be marketed. In the case of Optometry, we see this as being very much to the detriment of quality vision and eye care.

However, when the process of supplying ophthalmic devices becomes too demanding of a salesman's time to fit into the "profit realized vs. salesman's time" picture — when the patient's requirements fall outside the majority's statistical "norms", chains simply abandon all thought of engaging in such procedures. (What is a "norm" in terms of health care, anyway? It could well begin and end at 98.6°F and even that can be debated!)

It is specifically in providing those services not linked to the supply of devices that the optometrist has the opportunity to practice free of commercial pressures. And it is under that same heading where services related to Vision Therapy or Orthoptics, counselling and consulting to industry, schools and government can be placed.

But herein lies our conundrum — far too few optometrists are interested in these areas of practice any more. In fact, de-emphasizing this aspect of primary vision and eye care has probably come to the point that the profession may well lose it by default to others already organizing to fill the void.

Are commercial pressures and disinterest on the part of optometrists going to relegate this profession's role to that of a mere technician? (And there erupts a chorus of "No! Nay! Never!") But in the face of trial balloons like those floated recently by the Alberta Health Care Insurance Commission and Her Majesty's Government in the United Kingdom, we would suggest that the music from the orchestra may all too quickly be drowning out the chorus.)

We don't deny that elements like diagnostic (and, yes, even therapeutic) pharmaceuticals are a growing part of our present scope of practice and, in fact, we may well find them an essential part of our future. We are not suggesting that Optometry stop expending our energies in the continued struggle for professional enhancement. But rather, like the widely publicized recollections of Alex Haley, we are urging that all of us — optometrists, students and teachers alike — not lose sight of our professional roots in our quest for future growth.

As we continue to stretch the sphere labelled "Optometric Scope of Practice" we would do well to consider, at the same time, a renewed development and expansion of our own unique fields of expertise — Physiological Optics and Vision Therapy.

Optometry has the best trained personnel in these areas. Why are we voluntarily risking the degradation of our professional skills and the consequential usurpment of these services by others, if we continue to neglect the most basic — and as such, the most essential — elements of our profession?

**THE TIME FOR ACTION,
AND STRONG ACTION, IS NOW!**

GMB

Complete Text of CAO's June 14, 1988 Brief to the House Standing Committee on Health and Welfare

This past summer, CAO prepared and submitted a detailed Brief to the federal government's House of Commons Standing Committee on National Health and Welfare. The presentation was made by (then) President Dr. Scott Brisbin, Dr. M. Emerson Woodruff, acting as optometric consultant to CAO and Mr. Gérard Lambert, national Executive Director.

Long time practitioners will find the Brief to be an excellent refresher course on the roads taken by the profession to bring it to its present day position in the Canadian health care delivery system.

More recently established optometrists undoubtedly will find it interesting for the same reason.

New and long time practitioners alike will find it fascinating in what CAO presents for the federal government's consideration as possible options for the future of optometric vision and eye care in Canada.

It is with a great deal of pride that we reprint here the full text, in both English and French, of this benchmark document.

Part 1 — Introduction and Highlights

The Canadian Association of Optometrists (CAO) extends its thanks and appreciation to the Standing Committee of the Ministry of National Health and Welfare, on behalf of this country's Doctors of Optometry, for the opportunity to present its views on the provision of health services in Canada and, in particular, on vision and eye care services.

It has long been the view of CAO that Doctors of Optometry offer an opportunity for expanding the range of vision and eye care services in Canada.

As the one national organization representing the interests of the 2,700 optometrists of Canada, CAO also acts as the national "voice" of the profession, working on its behalf with government, industry, vision and eye care patients, other health professionals and the public at large.

Texte complet du mémoire du 14 juin 1988 de l'ACO au Comité permanent de la santé nationale et du bien-être social de la Chambre des communes

L'été dernier, l'ACO a préparé et présenté un mémoire détaillé au Comité permanent de la santé nationale et du bien-être social de la Chambre des communes du gouvernement fédéral. L'exposé a été fait par le président (d'alors) le Dr Scott Brisbin, qui était accompagné du Dr M. Emerson Woodruff, dont l'ACO avait retenu les services d'expert-conseil en optométrie, et de M. Gérard Lambert, directeur général national.

Les praticiens de longue date trouveront dans ce mémoire un excellent cours de mise à jour des connaissances sur le chemin que la profession a parcouru pour en arriver là où elle est aujourd'hui dans le réseau canadien des soins de santé.

Les optométristes établis depuis moins longtemps le trouveront sans doute intéressant pour la même raison.

Les praticiens, nouveaux et anciens, seront fascinés par les recommandations que l'ACO soumet à l'étude du gouvernement fédéral en tant qu'options possibles pour l'avenir des soins opculo-visuels au Canada.

C'est avec beaucoup de fierté que nous reprenons ici le texte intégral, en français et en anglais, de ce document repère.

Partie 1 — Introduction et Points Saillants

Au nom des docteurs en optométrie du pays, l'Association canadienne des optométristes (ACO) remercie le Comité permanent sur la Santé nationale et le Bien-être social et lui sait gré de l'occasion qu'il lui offre d'exposer ses vues sur la prestation des services de santé au Canada et en particulier sur les soins opculo-visuels.

L'organisation nationale représente 2 700 optométristes du Canada; l'ACO est également le porte-parole national de la pro-

We are pleased to present the views of the Canadian Association of Optometrists and we pledge to continue to improve the quality, quantity and cost effectiveness of the vision and eye care services available for all Canadians.

It has long been the view of CAO that Doctors of Optometry offer an opportunity for expanding the range of vision and eye care services in Canada, as well as for adding new services that presently are unavailable to a number of specific populations (or have been offered in the past and later were cancelled by a branch of either the Federal government or a provincial government).

Infants and pre-school children, senior citizens, Native Peoples, members of our Armed Forces, Canadians in Nursing Homes, Homes for the Mentally Handicapped and Correctional Institutions are all examples of sectors of the population whose vision and eye care needs Optometry feels could be better served than presently is the case within the Canadian Health Care Delivery System.

In this presentation, the Canadian Association of Optometrists is pleased to enlarge on proposals by which optometric training, expertise and services can be put to expanded use, economically, to the benefit of all Canadians.

Part 2 — Recommendations

To accomplish the objectives presented in this document, the Canadian Association of Optometrists recommends as follows:

(RECOMMENDATION 1)

That the appointment of an Optometric Consultant to the Ministry of National Health and Welfare be considered so that the delivery of vision and eye care services in Canada can be assessed and monitored in order to identify inadequacies and to propose alternatives to the existing delivery system;

Further to the above recommendation, we offer the following role description covering the duties and activities of the proposed Optometric Consultant:

In general, the mandate of the Optometric Consultant would include activities related to the development, maintenance and enhancement of the quality of vision care to the Canadian public.

The Optometric Consultant would attend conferences, lectures and presentations to other health care practitioners and/or their administrative representatives. (S)He would also advise the Minister of optometric vision and eye care and related issues.

More specifically, the Optometric Consultant would have overall responsibility in the following areas:

- (a) acting as a liaison between the Department and the Canadian Association of Optometrists (CAO), provincial optometric licensing bodies, the Canadian National Institute for the Blind (CNIB), the Canadian Hospital Association (CHA) and other national and provincial health organizations where matters of vision care are concerned;
- (b) representing the views of the Department in matters of vision and eye care of federal/provincial Committees and to other departments and governments as required;
- (c) monitoring activity and maintaining liaison with the United States Department of Health and Human Services where matters of vision care are concerned, with the International Optometric and Optical League (IOOL) and with similar groups in other countries as required.

fession, et en son nom, elle collabore avec le gouvernement, l'industrie, les patients oculo-visuels, les professionnels de la santé et le public en général.

**L'ACO croit depuis longtemps que
les docteurs en optométrie constituent
une ressource capable à la fois d'élargir
la gamme des services oculo-visuels
offerts au Canada.**

Nous sommes heureux de présenter les vues de l'Association canadienne des optométristes et nous nous engageons à poursuivre l'amélioration de la qualité, de la quantité et de la rentabilité des soins oculo-visuels offerts à tous les Canadiens.

L'ACO croit depuis longtemps que les docteurs en optométrie constituent une ressource capable à la fois d'élargir la gamme des services oculo-visuels offerts au Canada et d'offrir des services encore inaccessibles à des tranches de la population (ou des services offerts dans le passé et annulés plus tard par des organes du gouvernement fédéral ou des gouvernements provinciaux).

Les nourrissons, les enfants d'âge préscolaire, les personnes âgées, les autochtones, les membres de nos forces armées, les Canadiens dans les maisons de soins infirmiers, les centres pour personnes handicapées et les établissements correctionnels sont tous des exemples de populations dont les soins oculo-visuels, de l'avis de l'ACO, pourraient être supérieurs à ceux qui sont offerts présentement dans le régime canadien des soins de santé.

Dans ce mémoire, l'Association canadienne des optométristes est heureuse d'approfondir des propositions voulant que la formation, l'expertise et les services optométriques peuvent être étendus et offerts économiquement à tous les Canadiens.

Partie 2 — Recommandations

Afin d'atteindre les objectifs exposés dans ce document, l'Association canadienne des optométristes fait les recommandations suivantes :

(RECOMMENDATION 1)

Que l'on étudie la possibilité de nommer un consultant en optométrie auprès du ministère de la Santé nationale et du Bien-être social et qu'il soit chargé d'évaluer et de surveiller la prestation des soins oculo-visuels au Canada afin d'en relever les déficiences et de proposer des solutions de rechange au régime actuel.

Pour compléter la recommandation précédente, nous présentons une description du rôle, des devoirs et des activités du consultant en optométrie dont nous proposons la nomination :

Le mandat global du consultant en optométrie serait de veiller à la mise en oeuvre, au maintien et à l'amélioration de la qualité des soins oculo-visuels offerts au public canadien.

Le consultant en optométrie devrait assister aux conférences et aux exposés présentés aux professionnels des soins de santé ou leurs représentants administratifs. Le (la) titulaire de ce poste devrait aviser le ministre sur les soins oculo-visuels et optométriques et sur les sujets connexes.

D'une façon plus précise, le consultant en optométrie devrait assumer la responsabilité générale des domaines suivants :

In addition to the foregoing, the Optometric Consultant would participate in the development and implementation of national strategies for such matters as the following:

- (a) examining institutional vs. community provision of primary vision care services;
- (b) examining methods to ensure the best use of optometric personnel in programs related to (i) occupational and recreational eye safety, and (ii) the interpretation and application of federal recommendations on standards in Canada for the provision of eye care;
- (c) participating in interdepartmental Committees whose mandates include establishing and maintaining standards of vision and eye care for Canadians generally;
- (d) providing to the Minister a regular analysis of reports and documents for use in responding to public concerns;
- (e) preparing speeches and briefing notes for conferences and seminars where a specific eye care issue is to be addressed;
- (f) providing input on the optometric components of health care programs and policies while they are still in the developmental stages;
- (g) assisting in the evaluation of the economic and social costs of specific vision and eye care programs;
- (h) participating in the National Health Research Development Program where projects specific to vision and eye care are under consideration;
- (i) participating on National and Provincial committees and maintaining close contact with Schools of Optometry, optometric Associations and Colleges in Canada, the USA and other countries with a view to establishing National Standards both for optometric practice and optometric education;
- (j) relating the concerns of National Health and Welfare to the Medical Research Council (MRC), National Science and Energy Research Council (NSERC) and, internally, to the National Health Research and Development Program;
- (k) establishing liaison with the research programs at the Vision Institute of Canada and at the Schools of Optometry, University of Waterloo and l'Université de Montréal.

(RECOMMENDATION 2)

That the Federal Ministry of Health and Welfare guarantee the reimbursement, under provincial Health Care Insurance Plans, of the full range of optometric services and that, further, to conform to the federal government's definition of insurable services as are defined by the Canada Health Act, the Federal Ministry of Health and Welfare do what must be done to ensure that the provincial governments continue to provide the full range of optometric vision and eye care services as "medically required" under their health insurance plans:

(RECOMMENDATION 3)

That the Federal Ministry of Health and Welfare encourage Canada's provincial Governments to reimburse vision and eye care providers based upon the service provided, rather than on the basis of the professional from whom the service is received;

- (a) servir d'agent de liaison entre le Ministère et l'Association canadienne des optométristes (ACO), les organismes provinciaux qui émettent les permis d'optométriste, l'Institut national canadien des aveugles (INCA), l'Association des hôpitaux du Canada (AHC) et les autres organismes de santé nationaux et provinciaux qui se préoccupent des soins visuels;
- (b) présenter les vues du Ministère sur les soins opculo-visuels aux comités fédéraux/provinciaux et aux autres ministères et gouvernements, le cas échéant;
- (c) agir comme agent de liaison avec le Department of Health and Human Services des États-Unis, avec l'International Optometric and Optical League (IOOL) et avec d'autres organismes semblables d'autres pays et observer leurs activités dans le domaine des soins visuels.

De plus, le consultant en optométrie doit participer à l'élaboration et à la mise en oeuvre des stratégies nationales dans les domaines suivants :

- (a) étude des avantages respectifs de la prestation des soins visuels primaires par les établissements et par les collectivités;
- (b) étude des moyens d'utiliser au mieux le personnel optométrique oeuvrant dans les programmes (i) de sécurité oculaire dans les milieux de travail et de loisirs et (ii) d'interprétation et de mise en oeuvre des recommandations fédérales sur les normes canadiennes de la prestation des soins visuels;
- (c) participation aux comités interministériels dont le mandat comporte la mise en place et le maintien des normes des soins opculo-visuels dispensés aux Canadiens, en général;
- (d) présentation au ministre d'une analyse régulière des rapports et documents contenant des éléments de réponse aux problèmes du public;
- (e) présentation de discours et de notes pour les conférences et séminaires où des soins visuels particuliers seront étudiés;
- (f) préparation de données sur les composantes optométriques des programmes et politiques sur les soins de santé en élaboration;
- (g) apport à l'évaluation des coûts économiques et sociaux de programmes de soins opculo-visuels particuliers;
- (h) participation aux études du Programme national de recherche et de développement en matière de santé sur des projets explicites de soins opculo-visuels;
- (i) participation à la vie des comités nationaux et provinciaux et établissement de liens étroits avec les écoles d'optométrie, les associations et les collèges d'optométrie du Canada, des États-Unis et d'autres pays afin d'établir des normes nationales de pratique optométrique et de formation à l'optométrie;
- (j) rapport des préoccupations du ministère de la Santé nationale et du Bien-être social au Conseil de recherches médicales du Canada (CRMC), au Conseil de recherches en science naturelle et en génie du Canada (CRSNGC) et, à l'intérieur du ministère, au Programme national de recherche et de développement en matière de santé;
- (k) établissement de liens avec les programmes de recherche

Under the original draft terms of the Medical Care Act, restrictions had been proposed to allow federal cost-sharing only for those services provided by a physician, the most expensive provider. As a result of public input, however, the Act in its final form accommodated the public's demands for optometric services by introducing them as a public benefit, reimbursed directly by the provincial government.

Today, the situation holds true to some degree, albeit with newly imposed restrictions in several provinces, in every provincial jurisdiction except Prince Edward Island.

Further to the above recommendation, the Canadian Association of Optometrists (CAO) recognizes that, under the terms of the Canada Health Act, the federal government's cost-sharing formula has been altered to provide for block per capita funding to provincial governments. However, we also recognize that the federal guidelines for care, as expressed in the *Health Charter for All Canadians*, have been retained as the norms to which all provincial governments must adhere.

(RECOMMENDATION 4)

That the Government of Canada support the expansion and promotion of existing optometric Low Vision services and the foundation and operation of Low Vision clinics;

(RECOMMENDATION 5)

That the Government of Canada investigate ways and means by which the integration of optometrists into public health institutions in Canada can and may be implemented;

(RECOMMENDATION 6)

That the Government of Canada, in consultation with the various provincial governments and appropriate optometric vision specialists, commission a study on ways and means to expand available technology in the various provincial locations so that the proven benefits to the aged, the very young and all other segments of the Canadian population can be realized from such technology;

(RECOMMENDATION 7)

That the Government of Canada, in cooperation with the provinces, take steps to establish vision screening programs in Day Care Centres in order to identify children visually at risk;

Further, that provisions be made in such a program for the education of parents so as to reduce the prevalence of blinding traumas among children;

(RECOMMENDATION 8)

That National Health and Welfare, Medical Services Branch be empowered to add optometrical personnel to its professional staff so as to provide quality vision care to native Canadians in remote communities.

Part 3 — Background

“Thirty years ago, when Canadians set out to create our present system of universal health insurance and access to medical care, the implications of the World Health Organization's definition of health were *not* totally apparent to us. At that time, we believed that a system providing equal access to medical and hospital treatment of illness for all our people, regardless of ability to pay, would enable everyone to achieve the same level of health.”¹

The Hon. J. Epp
Minister of National Health and Welfare

du Vision Institute of Canada et des écoles d'optométrie de l'Université de Waterloo et de l'Université de Montréal.

(RECOMMENDATION 2)

Que le ministère fédéral de la Santé et du Bien-être garantisse le remboursement, dans le cadre des régimes d'assurance-santé provinciaux, de toute la gamme des services optométriques, et que, de plus, pour se conformer à la définition du gouvernement fédéral des services de santé assurés donnée dans la Loi canadienne sur la santé, le ministère fédéral de la Santé et du Bien-être fasse ce qu'il faut pour que les gouvernements provinciaux continuent d'offrir la gamme complète des services optométriques et oculo-visuels “médicalement nécessaires” en vertu de leur régime d'assurance-santé.

(RECOMMENDATION 3)

Que le ministère fédéral de la Santé et du Bien-être encourage les gouvernements provinciaux à rembourser les frais des soins oculo-visuels en fonction des services rendus plutôt qu'en fonction des professionnels qui les dispensent.

Dans sa version originale, la Loi canadienne sur la santé restreignait aux services rendus par un médecin, le plus dispendieux prestataire, la participation du fédéral aux frais. Mais suite aux pressions populaires, la Loi dans sa version finale répondait aux désirs du public de recevoir des services optométriques en les considérant comme des avantages publics remboursés directement par les gouvernements provinciaux.

Aujourd'hui, cette situation reste à peu près la même dans toutes les provinces, à l'exception de l'île-du-Prince-Édouard, encore que plusieurs provinces aient imposé de nouvelles restrictions.

Pour ajouter à la recommandation précédente, l'Association canadienne des optométristes (ACO) prend note que, conformément aux termes de la Loi canadienne sur la santé, le gouvernement fédéral a accepté de modifier sa formule de participation aux frais et de verser aux gouvernements provinciaux des blocs de financement proportionnels au nombre de leurs habitants. Elle sait cependant aussi que les principes directeurs du gouvernement fédéral en matière de soins, selon que les expose la Charte de santé des Canadiens, ont été retenus comme normes auxquelles tous les gouvernements provinciaux doivent se conformer.

(RECOMMENDATION 4)

Que le gouvernement du Canada supporte l'élargissement et la promotion des soins optométriques de basse vision existants ainsi que l'établissement et l'exploitation des cliniques de basse vision;

(RECOMMENDATION 5)

Que le gouvernement du Canada recherche des voies et moyens pour réaliser l'intégration des optométristes dans les établissements public de soins de santé;

(RECOMMENDATION 6)

Que le gouvernement du Canada, en consultation avec les gouvernements provinciaux et des optométristes spécialistes de la vue, commandent une étude sur les voies et moyens de répandre dans diverses localités provinciales les techniques disponibles afin que les personnes âgées, les nourrissons et tous les autres groupes de la population canadienne puissent en tirer tous les avantages éprouvés;

(RECOMMENDATION 7)

Que le gouvernement du Canada, en collaboration avec les pro-

"Pioneering the Future"

The 1988 Brock Chisholm Memorial Lecture
at the World Health Assembly
Geneva, Switzerland
May 3, 1988

"A New Perspective on the Health of Canadians² (the Lalonde Report, 1974) put forward the view that people's health was influenced by a broad range of factors: human biology, lifestyle, the organization of health care, and the social and physical environments in which people live. This representation of the factors contributing to health legitimized the idea of developing health policies and practices within a broader context.

Today, we are working with a concept which portrays health as a part of everyday living, an essential dimension of the quality of our lives. 'Quality of life' in this context implies the opportunity to make choices and to gain satisfaction from living. Health is thus envisaged as a resource which gives people the ability to manage and even to change their surroundings. This view of health recognizes freedom of choice and emphasizes the role of individuals and communities in defining what health means to them."³

The Hon. J. Epp
Minister of National Health and Welfare
"Achieving Health for All:
A Framework for Health Promotion"
November, 1986

It was in 1961 that a Royal Commission on Health stated: "Optometrists must be used and their qualifications upgraded".⁴

It was in 1961 that a Royal Commission on Health was appointed to promote the evolutionary process cited by Mr. Epp in 1986. In its report of 1964, the Commission stated: "Optometrists must be used and their qualifications upgraded"⁴

The Ontario Healing Arts Committee, in its 1970 report⁵, reached a similar conclusion, stating: "The exclusive use of ophthalmologists for vision care services is . . . impractical and wasteful. This makes it all the more imperative that decisions be made to improve the present and future effectiveness of optometrists in the health delivery system."

The Governments of Canada, Ontario and Quebec recognized the merits of these recommendations. Subsequently, the education and clinical training of optometrists was greatly improved when Schools of Optometry were incorporated in universities and funding provided for appropriate facilities with research capabilities. (The current role of the optometrist has been described in *The Canadian Journal of Optometry* * *la Revue Canadienne d'Optométrie*⁶ and in *The Canadian Encyclopedia*⁷.) The University base also provides training in a broad spectrum of technology which advances the profession's diagnostic and treatment capabilities, as will be outlined in a following section on the effects of technology.

Undergraduate / graduate education and vision research are carried out at both Canadian Schools of Optometry* and underlie the optometrist's capability to use the appropriate technology for patient benefit.

* School of Optometry, University of Waterloo / École d'Optométrie, Université de Montréal

vinces, prenne des mesures pour établir des programmes de dépistage des maladies de la vue dans les garderies afin de découvrir les enfants dont la vision présente des risques.

De plus, que des mesures soient prises dans ces programmes pour éduquer les parents de façon à réduire la prévalence de la cécité chez les enfants;

(RECOMMANDATION 8)

Que la Direction générale des services médicaux du ministère de la Santé et du Bien-être soit autorisée à adjoindre du personnel optométrique à son personnel professionnel afin d'offrir des soins visuels de qualité aux autochtones vivant dans les collectivités reculées.

Partie 3 — Historique

"Il y a trente ans, à l'époque où les Canadiens ont entrepris de mettre au point notre système actuel d'assurance-maladie et d'accès universel aux soins de santé, nous ne connaissons pas encore toutes les répercussions de la définition de la santé donnée par l'Organisation mondiale de la santé. À ce moment-là, nous croyions qu'un système qui assurerait à tous les gens, quelle que soit leur capacité de payer, l'égalité d'accès au réseau médico-hospitalier pour le traitement des maladies permettrait à tous d'atteindre le même niveau de santé."¹

L'honorable J. Epp
Ministre de la Santé nationale et du Bien-être social
"À l'avant-garde de l'avenir"
Conférence 1988 à la mémoire de Brock Chisholm
à l'assemblée de l'Organisation mondiale de la santé,
à Genève (Suisse),
le 3 mai 1988

Dans le rapport Lalonde de 1984 (*Nouvelle perspective de la santé des Canadiens*)², on pose l'hypothèse que la santé des gens dépend d'une vaste gamme de facteurs : biologie humaine, mode de vie, organisation des soins et contexte physique et social de vie. Cette façon de représenter les facteurs favorables à la santé a pavé la voie au concept de politiques et mesures de santé qui s'inscriraient dans un contexte plus vaste.

De nos jours, nous partons d'un concept selon lequel la santé est un aspect de la vie quotidienne, une dimension essentielle de la qualité de notre vie. Dans ce contexte, la qualité de la vie sous-entend la possibilité de faire des choix et de retirer de la satisfaction de sa vie. La vie serait donc une ressource donnant aux gens la capacité de gérer et même de façonner leur entourage. Cette conception de la santé reconnaît la liberté de choix et insiste sur le rôle des personnes et des collectivités dans la définition de ce que la santé signifie pour elles.³

L'honorable J. Epp
Ministre de la Santé nationale et du Bien-être social
"La santé pour tous :
plan d'ensemble pour la promotion de la santé",
novembre 1986

C'était en 1961 que la commission royale sur la santé des Canadiens recevait le mandat de promouvoir le processus évolutif dont parlait M. Epp en 1986. Dans son rapport de 1964, la Commission précisait ceci: il faut faire appel aux optométristes et relever leur compétence.⁴

The current Minister of Nation Health and Welfare, Mr. Jake Epp has also stated that "health public policy is concerned with extending responsibility for health to policy and decision makers in all sectors, at all levels."⁸

Part 4 — Identification of Long-Term Pressures for Growth

For our part, the Canadian Association of Optometrists has identified a number of factors which we feel will contribute to increased visual and ocular health expenditures.

Aging population

The history of the profession of Optometry in Canada has, since its inception, included a strong contribution to the continued good health and improved quality of life enjoyed by this country's senior citizen population.

The history of the profession of Optometry in Canada has, since its inception, included a strong contribution to the continued good health and improved quality of life enjoyed by this country's senior citizen population.

The eyes are subject to normal physiological changes as they age. The cells and crystalline lenses of the eyes grow throughout life and a decline in the eye's ability to change its shape and thickness occurs as early as age 10 or 11. These changes culminate in the onset of presbyopia (the reduction of focal ability as the eye ages) between ages 40 to 50. Thus, by these ages, most individuals will need some form of optometric therapy.

Except for the gastro-intestinal tract, all physiological systems are represented in the eyes. While poets have called the eyes the windows to the soul, it is much more apt to say, rather, that the eye offers a window through which many of the effects of disease on human biology become manifest before they are visible in other tissues or behaviours.

Smoking, alcohol abuse, environmental toxins, various drugs, social and physical environments (in both the short and long terms) all have detectable effects on the human visual system. Thus, examination of the eyes on a regular basis throughout life provides a preventive opportunity in many health conditions.

It is well established that cardio and cerebral vascular disease, as well as hypertension, are the greatest causes of change in the health of eyes. These increase in prevalence with age, as does the occurrence of glaucoma and adult onset diabetes.

(Documentation of the prevalence and the effects of these and other conditions is available in references^{9, 10, 11} from the Laboratory of Visual Epidemiology, School of Optometry, University of Waterloo.)

Optometrists have always dealt with conditions arising from aging of the visual system. Since 1968, in fact, their university programs have included lectures in gerontology and clinical experience in homes for the aged, nursing homes and hospital facilities for chronic care.

Optometric practitioners are specifically trained to assume responsibility for the role of primary vision care for the increasing numbers of persons aged 65 and over, whether they live in their own homes, residential homes, nursing homes or in chronic care hospitals.

As the data on National Health Expenditures¹² show, the annual

Dans son rapport de 1970⁵, le comité des arts médicaux de l'Ontario arrivait à une conclusion analogue : le recours exclusif aux ophtalmologistes pour les soins de la vue est . . . peu pratique et constitue un gaspillage. Il est autant plus important de prendre des décisions afin d'améliorer l'efficacité actuelle et future des optométristes dans le système des soins de santé.

Les gouvernements du Canada, de l'Ontario et du Québec ont reconnu les mérites de ces recommandations. Par la suite, la formation théorique et clinique des optométristes a été considérablement améliorée, par l'incorporation des facultés d'optométrie dans les universités et la mise à leur disposition d'une aide financière leur permettant de se doter d'installations adéquates et d'une capacité de recherche. (Le rôle actuel de l'optométriste a été décrit dans la *Revue canadienne d'optométrie*⁶ et dans la *Canadian Encyclopedia*⁷.)

L'Universitarisation a également permis un élargissement de la formation technique, faisant progresser les capacités de diagnostic et de traitement de la profession, comme nous le verrons plus loin, dans la section sur les effets de la technologie.

Il se fait de la formation de premier et deuxième cycles et de la recherche sur la vision dans les deux écoles canadiennes d'optométrie* et c'est ce qui permet aux optométristes d'utiliser les technologies appropriées à l'avantage de leurs malades.

L'actuel ministre de la Santé nationale et du Bien-être social, M. Jake Epp, a dit aussi qu'une politique saine s'efforce d'élargir la responsabilité en matière de santé aux décideurs, dans tous les secteurs et à tous les paliers.⁸

Partie 4 — Identification des Pressions de Croissance à Long Terme

L'Association canadienne des optométristes a dégagé un certain nombre de facteurs qui font augmenter les dépenses de santé consacrées à la vision et aux yeux.

Vieillessement de la Population

Depuis toujours, la profession d'optométriste au Canada a joué un rôle considérable dans le maintien de la santé et l'amélioration de la qualité de vie de nos aînés.

Les yeux subissent des changements physiologiques normaux, à mesure qu'ils vieillissent. Les cellules et le cristallin croissent toute la vie; dès l'âge de 10 ou 11 ans, on remarque un déclin dans la capacité de l'oeil d'adapter sa forme et son épaisseur. Ces changements deviennent pathologiques lorsque s'installe la presbytie (réduction de la capacité de focaliser, à mesure que les yeux vieillissent), entre 40 et 50 ans. Ainsi, à ces âges, la plupart des personnes auront besoin de certains soins d'optométrie.

Depuis toujours, la profession d'optométriste au Canada a joué un rôle considérable dans le maintien de la santé et l'amélioration de la qualité de vie de nos aînés.

À l'exception de l'appareil digestif, tous les systèmes physiologiques sont représentés dans les yeux. Même si les poètes y voyaient le miroir de l'âme, il serait beaucoup plus correct de dire que les yeux sont la fenêtre permettant de déceler nombre des effets de la maladie sur la biologie humaine, avant qu'ils ne soient visibles dans les tissus ou dans le comportement.

* Écoles d'optométrie de l'Université de Waterloo et de l'Université de Montréal

expenditures on optometric services (1975 - 1985, Table 9) show a more balanced pattern than that of any peer group.

Therefore, as the population ages, it is also reasonable to forecast that cost increases will follow in a similar ratio.

Low vision

At the present time, optometrists do staff Low Vision clinics (in some, but not all cases, in health care facilities and in co-operation with Ophthalmology, the Canadian National Institute for the Blind (CNIB) and with such other professionals as social and mobility workers), but only in the following centres in Canada: Montréal, Ottawa, Toronto, Waterloo, Winnipeg, Regina, Saskatoon and Kelowna, British Columbia.

Low Vision care is an area of service where new devices and recently available technology play an increasingly important part.

Optometry, through its 2,700 members in Canada, is in the forefront in the science of providing care for elderly persons who have lost their vision capability and require Low Vision services.

Low Vision care is an area of service where new devices and recently available technology play an increasingly important part and may result in a justifiable expenditure of public funds. Some of these costs, however, may be offset by maintaining the practitioner's mobility and thus limiting the costs of nursing care. (Reference 11 shows the decreasing level of mobility and the increase in supervisory care as vision capabilities are lost due to various causes.)

While the need for an optometrical role in Canadian hospitals has been amply demonstrated, the application of this role on the Canadian health care scene is currently not implemented to an acceptable level.

The Ontario Assistive Devices Program, which will extend Low Vision services to all visually handicapped persons in the province in January, 1989, will provide more specific information on costs when it reaches a state of stability, probably by 1991. Past this period, costs would rise or fall in proportion to increases or decreases in the various age groups.

Settings and the Employment of Technology

CAO strongly recommends an integration of optometrical services in the following public institutions of Canada:

1. Hospitals
2. Chronic Care Hospitals and Facilities
3. Nursing and Residential Homes and Geriatric Centres
4. Public Health Organizations and their programs
5. Centres for the Mentally and Physically Handicapped
6. The Canadian Armed Forces
7. National Health and Welfare / Medical Services Branch Programs for Native Peoples
8. Correctional Institutions

An increased scientific knowledge of visual physiology and ocular structure, as well as advances in technology, provides the impetus and urgency to bring about such integration.

Le tabagisme, l'alcoolisme, les toxines environnementales, les toxicomanies, l'environnement social et physique (à court et à long termes), tous ces facteurs ont des effets décelables sur le système visuel humain. Ainsi, l'examen oculaire périodique offre une mesure de prévention de nombreux problèmes de santé.

On sait bien que les maladies cérébrovasculaires et cardiovasculaires, ainsi que l'hypertension artérielle, sont les plus grandes causes de changement dans la santé des yeux. Leur occurrence augmente avec l'âge, tout comme celle du glaucome et du diabète adulte.

(On peut obtenir de la documentation sur la prévalence et les effets de ces pathologies et de certaines autres dans les ouvrages numérotés 9, 10, et 11 et disponibles au laboratoire d'épidémiologie visuelle de l'école d'optométrie de l'Université de Waterloo.)

Les optométristes sont formés spécialement pour assumer les responsabilités des soins primaires de la vue d'un nombre de plus en plus grand de personnes de 65 ans et plus, que ces personnes vivent chez elles, dans des résidences, foyers ou hôpitaux pour chroniques.

Comme on peut le constater dans le rapport sur les dépenses nationales de santé¹², les dépenses annuelles pour les services d'optométrie (1975 à 1985, tableau 9) permettent de voir une constante beaucoup plus équilibrée que dans les autres groupes équivalents.

En conséquence, puisque la population vieillit, il est tout aussi normal de prévoir que les coûts augmenteront au même rythme.

Basse Vision

Actuellement, les cliniques de basse vision ont des optométristes (dans certains cas, mais pas tous, dans des établissements de santé et en collaboration avec les ophtalmologistes, l'Institut national canadien pour les aveugles (INCA) et d'autres spécialistes, par exemple les travailleurs sociaux et spécialistes de la réadaptation), mais seulement dans certains centres canadiens : Montréal, Ottawa, Toronto, Waterloo, Winnipeg, Regina, Saskatoon et Kelowna (Colombie-Britannique).

L'optométrie, qui compte 2 700 membres au Canada, est à l'avant-garde, du point de vue scientifique, dans la prestation de soins de santé pour les personnes âgées qui ont perdu leur capacité visuelle et ont besoin de services de basse vision.

Les soins de basse vision sont un secteur où de nouveaux dispositifs et les technologies récentes jouent un rôle de plus en plus grand.

Les soins de basse vision sont un secteur où de nouveaux dispositifs et les technologies récentes jouent un rôle de plus en plus grand et il est possible, et justifiable, qu'on y consacre des fonds publics. Par contre, une partie de ces coûts pourrait être compensée par le maintien de la mobilité du praticien, d'où une réduction des coûts en soins de santé. (Dans l'étude portant le numéro 11 dans la bibliographie, on constate qu'il y a diminution du niveau de mobilité et augmentation des soins de surveillance, à mesure que les capacités visuelles diminuent, et cela pour diverses raisons.)

Le Programme d'appareils et de prothèses de l'Ontario, qui élargira les services de basse vision à tous les handicapés visuels de la province, à compter de janvier 1989, permettra d'obtenir des renseignements plus précis sur les coûts, lorsqu'il atteindra la stabilité, probablement vers 1991. Après cela, les coûts pourraient augmenter ou diminuer, proportionnellement aux augmentations ou diminutions dans les divers groupes d'âge.

The success of an optometrical role in hospitals has been well-demonstrated in both the United States¹³ and Great Britain¹⁴. The American Optometric Association¹⁵ reports that 30% of public hospitals in the United States have staff optometrists. Reports in the American Journal of Public Health^{16, 17} show nearly 50% of New York State's hospitals with staff optometrists.

While the need for an optometrical role in Canadian hospitals has been amply demonstrated, the application of this role on the Canadian health care scene is currently not implemented to an acceptable level.

Important and useful technological advances — for example, visually evoked responses, electro-retinograms, contrast sensitivity measures, photodocumentation of the external and internal eye, dynamic and static visual field measurements, laser interferometry and ultrasound — can be of great use in offering early preventive care to children, as well as in the prevention, detection, maintenance and rehabilitation of vision anomalies of elderly persons.

Through the private network of their own office settings, Canada's optometrists *can* and do support a major portion of these technological advances, but access to such services in institutional settings would make them more widely available to the Canadian public.

As a first step, the recognition of optometrical services as required medical acts in federal and provincial health legislation would provide optometrists with access to such facilities and continue their better integration within the health care team. (This use of optometrical services under just such a definition has been accomplished by the federal government of Australia¹⁸.)

Currently in this country, optometrical and ophthalmological training provides, in fact, two groups of practitioners who are adequately trained to provide vision and eye care for Canadians.

The Canadian Association of Optometrists agrees with the statement of the Canadian Medical Association:

"Canada has one of the best health care systems in the world. That system has worked because all of the partners in it have shared the responsibility for making it work. The maintenance of a quality system cannot be served by setting up areas of conflict between the partners involved. Changes to our health system demand the best ideas, the most careful consideration and the creative solutions which we are collectively capable of."¹⁹

One example of cooperation between Medicine and Optometry, to the benefit of their mutual patients is represented by a recent joint agreement between the British Columbia Association of Optometrists, the British Columbia Medical Association and its Section on Ophthalmology²⁰. This agreement illustrates that communication and coordination of three groups of health care providers can occur without pressures from Government.

Part 5 — Innovative Approaches for Meeting the Health Care Needs of Canadians

Knowledge of the brain, the visual system and their physiology has burgeoned over the past two decades. However, the benefits of the technology outlined here are not broadly accessible in Canada.

In particular, the nation's infants and young children lack access to early vision care where this technology contributes to diagnosis. In the age group from 0 - 5, approximately 10% of children who are considered to have no life-threatening conditions, and are otherwise normal, suffer from vision defects. Before or at age 3, these conditions can be treated so as to prevent visual sensory deficit. If left unattended, however, they will result in vision impairment

Environnements et Utilisation de la Technologie

L'ACO recommande fortement l'intégration des services d'optométrie dans certains établissements publics du Canada, à savoir :

1. hôpitaux
2. hôpitaux et installations de soins prolongés
3. foyers pour personnes âgées et centres de gériatrie
4. organismes d'hygiène publique (programmes compris)
5. centres pour handicapés physiques et mentaux
6. Forces armées canadiennes
7. programmes des autochtones de la Direction des services médicaux du ministère de la Santé nationale et du Bien-être social
8. établissements correctionnels

Ce qui suscite et rend plus urgente cette intégration, ce sont, en plus des progrès technologiques, de meilleures connaissances scientifiques de la physiologie de la vue et de la structure des yeux.

L'utilité de l'optométrie dans les hôpitaux a été démontrée avec succès, tant aux États-Unis¹³ qu'en Grande-Bretagne¹⁴. L'American Optometric Association¹⁵ précise que 30 % des hôpitaux publics des États-Unis comptent des optométristes dans leur personnel. Selon les rapports publiés dans l'American Journal of Public Health¹⁶, et ¹⁷ près de 50 % des hôpitaux de l'État de New York ont un service d'optométrie.

La nécessité d'un rôle pour l'optométrie dans les hôpitaux canadiens a été amplement démontrée mais, dans la pratique, le système canadien de santé ne s'est pas encore suffisamment ouvert aux optométristes.

La nécessité d'un rôle pour l'optométrie dans les hôpitaux canadiens a été amplement démontrée mais, dans la pratique, le système canadien de santé ne s'est pas encore suffisamment ouvert aux optométristes.

Des progrès technologiques importants et utiles, par exemple les potentiels évoqués cortico-visuels, l'électro-rétinographie, la mesure de la sensibilité différentielle, la photodocumentation de l'extérieur et de l'intérieur de l'oeil, les mesures dynamiques et statiques du champ visuel, l'interférométrie laser et les ultrasons, peuvent être très utiles et devenir autant de moyens préventifs pour le soin des enfants et pour prévenir, déceler, traiter et compenser les anomalies de la vue chez les personnes âgées.

Par le réseau privé que constituent leurs cabinets, les optométristes du Canada peuvent appuyer et appuient une grande partie de ces progrès technologiques, mais l'accès à ces services en établissement les mettrait à la portée d'un plus grand nombre de Canadiens. Comme première étape, la reconnaissance des services d'optométrie en tant qu'actes médicaux requis, dans les lois fédérales et provinciales sur la santé, ouvrirait aux optométristes l'accès à ces installations et favoriserait une meilleure intégration de ces spécialistes des soins de santé. (L'utilisation des services d'optométrie dans une définition similaire a été réussie par le gouvernement fédéral de l'Australie.¹⁸)

Actuellement, la formation en optométrie et en ophtalmologie donne en réalité deux groupes de professionnels formés adéquatement pour offrir aux Canadiens des soins de la vue et des yeux.

L'Association canadienne des optométristes ne peut qu'applaudir à ce que publiait dans les journaux l'Association médicale canadienne :

that cannot be remedied to the same extent as the children age beyond 6 years. Examples of deficits of this kind are amblyopia, strabismus, etc.

Since the early 1970's, optometric graduates have been trained to use this available technology to detect, diagnose and treat visual problems of children under the age of 6.

In the age group from 0 -5, approximately 10% of children who are considered to have no life-threatening conditions, and are otherwise normal, suffer from vision defects.

Research from the University of Waterloo's Laboratory of Visual Epidemiology has identified various child populations which show higher rates of vision and eye problems. These are the mentally handicapped²¹, deaf children²², Indian children²³, children of mothers on welfare and children of battered women²⁴.

A broad spectrum of risk factors²⁵ has also been identified. To mention a few: children of mothers who smoke during pregnancy, the maternal abuse of alcohol, the maternal use of illicit and prescribed medications, various viral infections and low birth weight.

Among the populations mentioned above, from 30 to 65 percent of children may need and benefit from early diagnosis and care.

The announcement in December, 1987 of a National Strategy on Child Care offers an excellent opportunity for an innovative activity in detecting and caring for the visual problems of children 5 years of age and younger.

In the type of day care programs recommended, large numbers of children are assembled and can be screened for vision and eye problems. Optometrists have been trained and involved in such screenings in the areas surrounding the Universities of Montréal and Waterloo since the early 1970's.

Day care centres could also serve as sites for the education of mothers about the care and protection of children's eyes and vision.

Day care centres could also serve as sites for the education of mothers about the care and protection of children's eyes and vision. This is a particularly important part of health promotion, since the majority of cases of blindness in children are caused by trauma as a result of accident.

The necessity of such a health policy has recently been stressed by Keith Spicer, Editor of *The Ottawa Citizen*, on April 9, 1988, when he said,

"In this aging population, even the baby boomers are moving into middle age. It should be obvious, too, that economic prosperity is not trickling down to a big chunk of the population — single mothers, native people, those working at the minimum wage, the middle-aged worker displaced from the labour force."

A study carried out by investigators at McMaster University²⁶ has documented the effective outcome of such screening and vision care programs.

Le Canada possède l'un des meilleurs systèmes de soins de santé au monde. Ce système a fonctionné parce que tous ceux qui y participent ont partagé la responsabilité de faire en sorte qu'il fonctionne. Si nous voulons maintenir un système de qualité, il faut éviter les points de conflit entre les participants. La modification de notre système de santé exige les idées les meilleures, la réflexion la plus approfondie et les solutions les plus originales dont nous sommes collectivement capables.¹⁹

La médecine et l'optométrie peuvent collaborer, pour le mieux-être de leurs malades. Prenons comme exemple de cela une entente conjointe intervenue récemment entre la British Columbia Association of Optometrists et la British Columbia Medical Association et sa section d'ophtalmologie.²⁰ Cette entente illustre qu'il peut y avoir communication et coordination, dans trois groupes fournisseurs de soins de santé, sans pression de la part du gouvernement.

Partie 5 — Solutions Originales pour Répondre aux Besoins de Soins de Santé des Canadiens

Depuis deux décennies, les connaissances sur le cerveau et l'appareil visuel et sur leur physiologie ont progressé à pas de géant. Cependant, la technologie décrite ici n'est pas universellement offerte au Canada.

Dans les 0 à 5 ans, environ 10 % des enfants souffrant d'une maladie non mortelle et autrement normaux ont un problème visuel.

À titre d'exemple, les nourrissons et les jeunes enfants n'ont pas suffisamment accès aux soins visuels primaires, dans les cas où cette technologie permet de porter un diagnostic. Dans les 0 à 5 ans, environ 10 % des enfants souffrant d'une maladie non mortelle et autrement normaux ont un problème visuel. Jusqu'à 3 ans, on peut traiter ces problèmes de façon à prévenir un déficit de perception visuelle. Cependant, faute de soins, ces problèmes dégénéreront en handicap visuel qui ne pourra être corrigé dans la même mesure, si les enfants ont plus de six ans. Parmi les exemples de déficits de ce type, mentionnons l'amblyopie, le strabisme, etc.

Depuis le début des années 1970, les diplômés des écoles d'optométrie ont été formés à utiliser cette technologie pour déceler, diagnostiquer et traiter les problèmes visuels des enfants de moins de six ans.

Les recherches menées au laboratoire d'épidémiologie visuelle de l'Université de Waterloo ont permis d'identifier diverses populations d'enfants où les troubles de la vision et des yeux ont une incidence plus élevée. Il s'agit des enfants handicapés mentalement²¹, des enfants sourds²², ou autochtones²³, des enfants de mères sur le bien-être ou de femmes battues²⁴.

En outre, les chercheurs ont dégagé une large spectre de facteurs de risque²⁵, par exemple : les enfants dont la mère fume pendant la grossesse ou abuse de l'alcool ou utilise des médicaments sur ordonnance ou des drogues; diverses infections virales et le manque de poids à la naissance.

Parmi les populations mentionnées ci-dessus, de 30 à 65 % des enfants peuvent avoir besoin et bénéficier d'un diagnostic et de soins hâtifs.

L'annonce, en décembre 1987, d'une Stratégie nationale sur la garde d'enfants offrait une excellente possibilité de mettre en place

A Note on How Not to Improve Health Services in Canada

In 1980, the Ministry of National Health and Welfare's Medical Services Branch, citing fiscal restraint, cut a program of vision care to Native Peoples. It had provided over 11,000 children with an annual program of assessment and care in all four regions of Ontario for the previous ten years. The quality and the quantity of the care delivered by the program has not been matched since that time.

Sadly, this confirms one area of Mr. Spicer's comments, although this too could be remedied by innovative action and cooperation between government, optometrists and the Schools of Optometry.

Vision and Ocular Health Promotion

The Lalonde Report of 1974 advocated using *prevention* as a major weapon against illness. Such prevention, by its very nature, begins with the early examination of patients and, as related to vision and eye care, the early communication of the appropriate preventive information.

Prevention, by its very nature, begins with the early examination of patients and, as related to vision and eye care, the early communication of the appropriate preventive information.

Optometrists have played an important part in the United States National Institute of Health's program in the promotion of education on early detection and continuous monitoring of hypertension, cardio, cerebral and vascular disease.

The decrease in these conditions over the past decade may well have been influenced by this type of national health promotion activity. In Canada, federal health programs such as "Participation" have always been supported by Canada's optometrists.

The Canadian Association of Optometrists (CAO) has annually sponsored "Save Your Vision Week" in which various and specific vision and ocular conditions have been presented to all sectors of society. Since 1985, optometric vision and eye care promotion during Save Your Vision Week has been broadened through the involvement of prominent Canadians, and the endorsement of the Prime Minister, in which attention has been drawn to the necessity of preventive and corrective vision care and protection of vision and the eyes at home, work, school and in recreational environments.

CAO and all its corporate member provincial Associations of Optometrist have, for many years, supplied health promotion materials through their offices and practitioners to the public.

Special promotional programs have included, for example, recommendations for the protection of the eyes during an eclipse of the sun. This particular initiative has always been picked up and widely reported by the media and has contributed directly to a reduction of eclipse damage to the retinae (eclipse retinopathy) of persons of all ages.

CAO has also promoted public knowledge through news conferences, television public service announcements and other media, informing Canadians on a variety of vision and eye care issues and, most recently, on smoking-related risks to vision.

The Association has contributed to the formation of vision standards with both the federal and various provincial governments. Recently, CAO has drawn the matter to the attention of the public and the profession with the publication of these standards in both

des activités originales de détection et de soins des problèmes visuels chez les enfants de 5 ans ou moins.

Dans les programmes du genre de ceux recommandés en garderie, on peut réunir un grand nombre d'enfants et leur faire passer des tests pour vérifier s'ils ont des problèmes visuels ou oculaires. Depuis le début des années 1970, les optométristes ont été formés en conséquence et ont pris part à des évaluations de ce genre dans les secteurs desservis par les universités de Montréal et de Waterloo.

En outre, les garderies pourraient servir de lieu d'éducation des mères sur le soin et la protection des yeux et de la vision des enfants.

En outre, les garderies pourraient servir de lieu d'éducation des mères sur le soin et la protection des yeux et de la vision des enfants. C'est un aspect particulièrement important de la promotion de la santé, car la majorité des cas de cécité chez les enfants sont causés par des traumatismes résultant d'un accident.

Dans l'édition du 9 avril 1988 du quotidien *The Ottawa Citizen*, Keith Spicer, qui en est le rédacteur en chef, a insisté sur la nécessité d'une politique de santé comme celle-là :

La population vieillit et même les enfants du baby-boom entament la quarantaine. De plus, il devrait être évident que la prospérité économique est loin de retomber sur la majorité de la population, par exemple les mères célibataires, les autochtones, ceux qui travaillent au salaire minimum, les travailleurs d'âge moyen mis en disponibilité.

Des chercheurs de l'Université McMaster²⁶ ont mené une étude sur l'efficacité de ces programmes de dépistage et de soin de la vision.

Quel est le Meilleur Moyen de Ne Pas Améliorer les Services de Santé au Canada

En, 1980, le ministre de la Santé nationale et du Bien-être social (Direction des services médicaux) mettait fin à un programme de soins de la vue pour les autochtones, en invoquant les restrictions financières. Depuis dix ans, ce programme avait permis d'évaluer et de traiter annuellement plus de 11 000 enfants dans les quatre régions de l'Ontario. Qualitativement et quantitativement, les soins offerts par le programme n'ont pas été égalés depuis.

Il est triste de constater que cela confirme certaines des remarques de M. Spicer, mais on pourrait y remédier, si le gouvernement se décidait à agir avec un peu d'originalité et à collaborer avec les optométristes et les écoles d'optométrie.

Promotion des Soins Oculo-Visuels

Le rapport Lalonde de 1974 préconisait la *prévention* comme principale arme contre la maladie. Par nature, la prévention se fonde sur l'examen hâtif des malades et, en ce qui a trait aux soins oculo-visuels, à la communication immédiate des renseignements préventifs adéquats.

Les optométristes ont joué un rôle important, aux États-Unis, dans le programme mis sur pied par la National Institute of Health pour sensibiliser la population et promouvoir le dépistage hâtif et la surveillance continue de l'hypertension et des maladies cardio-vasculaires et cérébrovasculaires.

The Canadian Journal of Optometry * *la Revue Canadienne d'Optométrie*²⁷ and *The Optometrist's Desk Reference*²⁸.

CAO also cooperated with the Canadian and US Centres for Disease Control in formulating office procedures to protect optometrists, contact lens wearers and other patients against the chance of exposure to the AIDS antibodies through tear fluids or through contact with those already infected by AIDS who use optometric services.

Optometrists and their office personnel are seen by CAO as ideal providers of a full spectrum of information to patients. Thus, one may well find that a pamphlet on diabetes, hypertension, glaucoma, stroke and heart disease etc. is discussed and distributed to patients along with the CAO's own vision-related materials. Many practitioners and Associations also mount programs in health fairs held at the local level by community health groups.

CAO also supported, and still promotes, the program to encourage the mandatory installation of vehicle Daytime Running Lights in order to reduce the injury and fatality rates on the nation's highways, a program which, in fact, was initiated by the profession of Optometry some 25 years ago.

The American Optometric Association has cooperated with the US Department of Health and Human Services and its National Institutes of Health in an annual High Blood Pressure Month. Kits of information and methods of promotion are provided, as is training, in order to maximize the impact of the awareness program.

Canadian Optometry and other health professions could be brought into a similar national program contributing to the early detection of hypertension to further reduce its long-term effects on our population. CAO would be pleased to cooperate with the federal and provincial governments and its fellow health professionals in the nationwide implementation of such an awareness program in this country.

Optometrists are the first-line professionals in the area of visual and ocular health. As such, they have developed a wide range of health promotion initiatives. To improve their role in this regard, however, to the benefit of all Canadians, the optometrists of this country must also be party to the full range of health promotion initiatives initiated and/or supported by the Government of Canada.

Part 6 — Conclusion

As noted in the introduction to this Brief, it has long been a goal of the Canadian Association Optometrists to ensure that the training and abilities of its members — the 2,700 Doctors of Optometry in Canada — are employed to the best possible advantage of all Canadians.

We will continue to strive towards this goal and, to that end, offer our thanks to the Members of the Committee for this opportunity to present our views on ways and means of expanding and improving the range of vision and eye care services available in Canada.

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Executive Director

La diminution de ces problèmes depuis une décennie pourrait bien être le fait de ce type de promotion de la santé à l'échelon national. Au Canada, plusieurs programmes fédéraux, par exemple "Participation", on toujours reçu l'appui des optométristes canadiens.

L'Association canadienne des optométristes (ACO) parraine actuellement la Semaine de la vision, où elle fait connaître à tous les secteurs de la population divers problèmes oculo-visuels. Depuis 1985, la promotion des soins oculo-visuels pendant la Semaine de la vision a pu être élargie, par la participation de personnalités canadiennes et l'appui du Premier ministre : on a ainsi attiré l'attention des Canadiens sur la nécessité des soins visuels préventifs et correctifs et de la protection de la vision et des yeux, à la maison, au travail, à l'école et dans les loisirs.

L'ACO et ses membres collectifs, c'est-à-dire les associations provinciales d'optométristes, ont, depuis nombre d'années, distribué à la population du matériel de promotion de la santé, par leurs bureaux et les cabinets de leurs membres.

Parmi les programmes spéciaux de promotion, mentionnons par exemple les recommandations relatives à la protection des yeux pendant les éclipses solaires. Cette initiative a toujours été fortement soulignée par les médias et a directement favorisé la diminution des dommages rétinien dus aux éclipses (photo-rétinite) chez les citoyens de tous âges.

Les optométristes sont les spécialistes qui
oeuvrent en première ligne, dans le
domaine des soins oculo-visuels.

En outre, par des conférences de presse, la télédiffusion d'avis publics et d'autres moyens, l'ACO a informé les Canadiens sur toutes sortes de questions touchant les soins de la vision et des yeux et, tout récemment, sur les risques de l'usage du tabac.

L'Association a favorisé la formation de normes de la vision, aux échelons fédéral et provincial. Récemment, l'ACO a porté cette question à l'attention de la population et de ses membres, avec la publication de ces normes dans *la Revue canadienne d'optométrie*²⁷ et le *Livre de référence de l'optométriste*²⁸.

L'ACO a de plus collaboré avec les centres canadiens et états-uniens de lutte contre les maladies, à la formulation de modalités pratiques afin de protéger les optométristes, les porteurs de lentilles cornéennes et autres personnes contre les risques d'exposition aux anticorps du SIDA par les larmes ou par contact avec des personnes déjà infectées par le SIDA et recourant aux services des optométristes.

Les optométristes et leur personnel sont, pour l'ACO, les fournisseurs tout indiqués d'une mine de renseignements. Ainsi, il n'est pas rare que des dépliants sur le diabète, l'hypertension, le glaucome, les maladies cérébrovasculaires et coronariennes, etc., fassent l'objet de discussions ou soient distribuées aux malades, en même temps que les publications de l'ACO. Nombre de praticiens et d'associations organisent également des programmes, dans les expositions organisées par des groupes communautaires de promotion de la santé.

L'ACO continue à donner son appui au programme visant l'installation obligatoire de phares diurnes sur les voitures, afin de réduire les taux de blessure et de mortalité sur les routes. Ce programme a été en fait lancé par les optométristes il y a environ 25 ans.

L'American Optometric Association a prêté son concours au Department of Health and Human Services des États-Unis et à ses

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instituts nationaux de la santé, dans l'organisation de sa campagne annuelle du mois de l'hypertension. Pour maximiser l'effet du programme de sensibilisation, on a mis au point des trousseaux d'information et des méthodes de promotion et organisé des séances de formation.

Les optométristes canadiens et d'autres professionnels de la santé pourraient être amenés à participer à des programmes nationaux analogues favorisant le dépistage hâtif de l'hypertension, afin de réduire ses effets à long terme sur la population. C'est avec plaisir que l'ACO collaborerait avec le fédéral, les provinces et les autres spécialistes de la santé, pour une mise en place à l'échelle du pays d'un programme de sensibilisation de ce type.

Les optométristes sont les spécialistes qui oeuvrent en première ligne, dans le domaine des soins opculo-visuels. À ce titre, ils ont pris toute une gamme d'initiatives favorisant la santé. Cependant, les optométristes souhaitent jouer à ce propos un meilleur rôle, à l'avantage de tous les Canadiens; ils doivent donc être de toutes les initiatives de promotion de la santé lancées ou appuyées par le gouvernement du Canada.

Partie 6 — Conclusion

Comme nous l'avons mentionné dans l'introduction du présent mémoire, il y a longtemps que l'Association canadienne des optométristes a pour objectif de faire en sorte que la formation et les capacités de ses membres, les 2 700 docteurs en optométrie du Canada, soient utilisées pour le plus grand avantage de tous les Canadiens.

Nous continuerons à travailler dans ce but et, à cette fin, nous remercions les membres du Comité de nous avoir donné l'occasion de faire connaître notre point de vue sur les moyens et possibilités d'élargir et d'améliorer l'éventail des soins et services opculo-visuels offerts au Canada.

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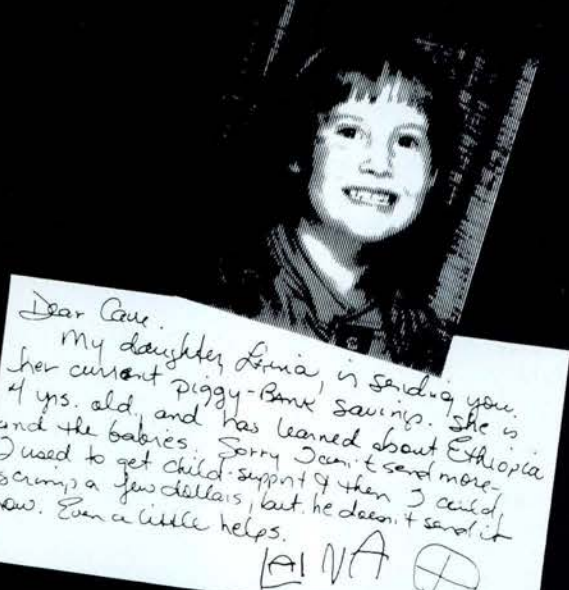
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Pupillary Dilation in Clinical Practice

R.C. Trevino *

Pupillary dilation facilitates examination of the ocular fundus and media. A dilated pupil not only permits ophthalmoscopic examination of the otherwise inaccessible regions of the peripheral fundus, but it also allows utilization of instruments which offer stereopsis. An example of such an instrument is the binocular indirect ophthalmoscope. With this instrument the entire fundus from posterior pole to pars plana may be readily examined. The non-mydiatic adjustment available on some binocular indirect ophthalmoscopes brings the observation and illumination beams very close together to allow viewing through smaller pupils. This arrangement increases reflections, reduces stereopsis, and ophthalmoscopy is generally limited to the posterior fundus.¹ As a rule, the larger the pupil the easier it becomes to view the peripheral fundus.

A dilated pupil not only permits ophthalmoscopic examination of the otherwise inaccessible regions of the peripheral fundus, but it also allows utilization of instruments which offer stereopsis.

Historically, optometrists have been prohibited by law from utilizing mydriatic agents in their practice, but this is changing. There are now six provinces in which optometrists use diagnostic pharmaceutical agents (DPAs): Alberta, British Columbia, Manitoba, New Brunswick, Nova Scotia and Ontario. Only two of the 50 United States still prohibit the use of DPAs by optometrists, and 20 states permit use of therapeutics.

As the laws governing the practice of optometry change, it is important that each practitioner remain abreast of the indications, contraindications and potential adverse effects of each pharmaceutical being utilized.

As the laws governing the practice of optometry change, it is important that each practitioner remain abreast of the indications, contraindications and potential adverse effects of each pharmaceutical being utilized. This paper reviews indications, precautions and protocol regarding the use of mydriatic agents.

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Indications

Pupillary dilation is a simple and safe clinical procedure which can be incorporated into routine optometric practice. One need not dilate every patient to derive the maximum benefit from this procedure, only those for whom the procedure is indicated. In general, every patient with either known or suspected intraocular disease should receive a dilated fundus examination. Included are patients that fall into so-called "at risk" populations for intraocular disease. Although by no means a comprehensive list, some of the more common and widely recognized indications for dilated fundus examination include.

- 1) Age. Many ocular diseases are more prevalent among the elderly.² Direct ophthalmoscopy is often more difficult in the aged because of cloudy media and miotic pupils. Consequently, many practitioners have adopted a policy of performing dilated fundus examinations on all first-time patients over a given age (such as 40 years of age) and then repeating the procedure on a routine basis every few years thereafter.
- 2) Myopia. The higher degrees of myopia are associated with an increased prevalence of a wide range of ocular disorders; included are vitreous and chorioretinal degenerations, posterior staphyloma, subretinal neovascularization, retinal detachment, glaucoma and cataract.³ High magnification and poor image quality make examination by direct ophthalmoscopy extremely difficult. Regular examination of high myopes with indirect ophthalmoscopy is essential to the proper management of these patients.
- 3) Trauma. Patients presenting with trauma deserve a dilated fundus examination to rule out the presence of intraocular injury. Keep in mind that the external appearance of an eye after blunt trauma is not an accurate indicator as to whether or not intraocular injury has occurred.⁴
- 4) Predisposing Systemic Disease. Individuals suffering from conditions known to produce fundus or lens changes should be dilated on a regular basis to facilitate disease detection and monitoring. Examples of such conditions include diabetes, hypertension, sickle cell disease, systemic lupus erythematosus, and sarcoidosis. In addition, patients taking medications with high ocular toxicity need to be closely monitored. Two major offenders in this area are the phenothiazines and chloroquine. Phenothiazines are used in the treatment of mental illness and chloroquine is used to treat rheumatoid arthritis and other collagen-vascular diseases.
- 5) Symptomatic Patients. Dilated fundus examination is indicated whenever a patient presents with symptoms suggestive

of intraocular disease. Such symptoms would include photopsia, floaters, metamorphopsia, vision or field loss.

- 6) Mydriasis is indicated anytime careful examination of the ocular fundus or media is desired.

Pupil dilation should not be performed if either angle-closure glaucoma, an iris-supported intraocular lens implant, a subluxated crystalline lens, or a subluxated posterior chamber intraocular lens implant is present.

Pupil dilation should not be performed if either angle-closure glaucoma, an iris-supported intraocular lens implant, a subluxated crystalline lens, or a subluxated posterior chamber intraocular lens implant is present.⁵ Eyes with iris-supported implants should not be dilated unless it is absolutely necessary, and then only after consultation with an implant surgeon. Patients with angle-closure glaucoma, lens subluxation, or a subluxed posterior chamber implant require surgical attention before they can be dilated safely.

Mydriatic Selection

A standard regimen for routine dilation is to instill a topical anesthetic followed by one drop each of 1.0% tropicamide and 2.5% phenylephrine.⁶ The anesthetic serves to increase the permeability of the corneal epithelium while minimizing discomfort and reflex lacrimation during subsequent drop instillations. The anticholinergic activity of tropicamide relaxes the iris sphincter muscle (and also the ciliary body – causing cycloplegia) while the adrenergic activity of phenylephrine stimulates the dilator. Together these agents act synergistically to produce a rapid and full dilation of the pupil. Only rarely will additional instillations ever be needed to obtain a clinically effective (6 mm or greater pupillary diameter⁷) dilation. Bartlett⁶ recommends against the use of tropicamide alone for routine dilation for the following three reasons:

- a) The above combination produces a faster and more complete mydriasis.
- b) Tropicamide alone often produces insufficient mydriasis in elderly patients.
- c) Pupils dilated with tropicamide alone may constrict in response to the intense illumination of the binocular indirect ophthalmoscope.

Other agents are available for purposes of pupillary dilation. Atropine, homatropine, scopolamine and cyclopentolate are anticholinergic agents readily available for ophthalmic use. Although each agent has clinical applications, these drugs are not advisable for routine dilation primarily because their duration of action is too long.

Only hydroxyamphetamine is available as an alternative adrenergic agent. The mydriatic effectiveness of 1.0% hydroxyamphetamine is approximately equivalent to 2.5% phenylephrine.⁶ It can be used as an alternative to phenylephrine in selected patients at risk for cardiovascular side effects.

Tropicamide is commercially available in 0.5% and 1.0% solution. Both provide approximately equal mydriasis. Although controversial⁸, some believe that the 1.0% concentration may offer greater effectivity in darkly pigmented individuals.⁹ No serious

toxic effects have been associated with the topical use of tropicamide; in fact, tropicamide is considered to be one of the safest of all DPAs.^{10, 11}

Phenylephrine is commercially available in 2.5% and 10% solution for purposes of pupillary dilation. The 2.5% concentration is recommended for routine mydriasis because the vast majority of reported systemic adverse effects, such as elevation of blood pressure, involve use of the 10% concentration.^{12, 13} For routine pupillary dilation the risk of cardiovascular effects associated with the use of 10% phenylephrine outweigh its benefit of slightly greater effectivity.

Although the suggested regimen of choice for routine mydriasis is one drop each of 1.0% tropicamide and 2.5% phenylephrine, this may, as discussed below, be adjusted in patients with either a narrow anterior chamber angle or those at risk for the potential cardiovascular effects of phenylephrine.

Suggested Protocol

1. Predilation Testing

Once it has been decided that a given patient shall be dilated, certain testing needs to be carried out before mydriatics can be instilled safely. Generally speaking, only the fundus examination and a post-dilation slitlamp examination should remain to be performed after mydriasis. An exception would be when a cycloplegic refraction is desired. In addition to a careful medical history, there are four test which may be routinely performed on all patients prior to mydriatic instillation: visual acuity, biomicroscopy, pupillary reflexes, and tonometry. The purpose for performing each is as follows:

Generally speaking, only the fundus examination and a post-dilation slitlamp examination should remain to be performed after mydriasis.

- a) Best corrected visual acuity. Acuity is usually assessed on every patient, if only for medico-legal reasons. Whenever the patient's corrected distance acuity is less than 6/6 – 6/7.5, a pinhole acuity or refraction is needed to determine whether uncorrected refractive error is the cause of the reduction. Any refractive analysis, near vision testing, or binocular vision assessment should be carried out prior to dilation.
- b) Biomicroscopy. The depth of the anterior chamber angle must be established prior to dilation if angle-closure is to be avoided. van Herick and associates¹⁴ have devised a very useful slitlamp estimation technique for this purpose (Table 1). Gonioscopy is performed whenever the estimation technique indicates that an angle is capable of closure. If the angle appears dangerously narrow on gonioscopy, the patient should be evaluated for the presence of angle-closure glaucoma. In addition to evaluating anterior chamber depth during biomicroscopy, search for any other contraindications to pupillary dilation, such as an iris-supported implant or a subluxed lens.
- c) Pupillary testing. Naturally, once the pupils have been dilated it is not possible to examine their reflexes. If you wish to examine the pupils, do so prior to mydriatic instillation.
- d) Tonometry. Intraocular pressure (IOP) is normally not significantly affected by pupillary dilation.⁶ In some patients

TABLE 1

Van Herick Estimation Procedure

1. Position the narrowest possible slitbeam at an angle almost perpendicular to the peripheral corneal surface at a point just anterior to the limbus.
2. View the chamber opening at a 60° angle to the light beam.
3. The corneal section width is used for estimating the anterior chamber angle depth as follows:
 - Grade 4** (Incapable of closure)-The distance between the posterior corneal surface and the iris (corneal-iris space) is equal to or greater than the section width of the cornea.
 - Grade 3** (Incapable of closure)-The space is equal to one half the width of the corneal section.
 - Grade 2** (Closure possible)-The space is equal to one fourth of the corneal section width.
 - Grade 1** (Closure probable)-The distance is less than one fourth of the width of the corneal section.
4. To avoid errors in estimation keep the slitlamp beam as narrow as possible and use the area just before the point of disappearance of the corneal-iris space at the periphery for measurement.
5. If the angle is grade 1 or 2, gonioscopy is indicated to rule out potential closure.

From Van Herick, W., R. Shaffer, A. Schwartz: Estimation of Width of Angle of Anterior Chamber. AM. J. Ophthalmol. 68(4): 626 - 29, 1969.

TABLE 2

Guidelines for the Clinical Use of Topical Ophthalmic 2.5% Phenylephrine

1. Use is contraindicated in:
 - A) Some low birth weight infants
 - B) Patients with known cerebral aneurysms
 - C) Elderly adults with severe arteriosclerotic, cardiovascular, or cerebrovascular disease
2. Monitor blood pressure in geriatric patients with known cardiac disease.
3. Careful supervision and adjustment of dosages are required when monoamine oxidase inhibitors or tricyclic antidepressants are administered simultaneously or with 21 days.
4. Use caution in infants with known cardiac anomalies.
5. Be aware that concomitant use of topical ocular phenylephrine in patients given atropine can enhance pressor effects and induce tachycardia in some patients, especially infants.

From Fraunfelder, F.T., S.M. Meyer: Possible Cardiovascular Effects Secondary to Topical Ophthalmic 2.5% Phenylephrine. AM. J. Ophthalmol. 99(6): 362 - 63, 1985.

with open-angle glaucoma anticholinergic mydriatics can produce a substantial but transient rise in IOP.¹⁰ Consequently, measurements of ocular tension should be made prior to dilation rather than afterwards to avoid artificially elevated readings in these patients. Furthermore, baseline tonometric readings are useful whenever the possibility of angle-closure glaucoma is a concern.



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2. Drug instillation

A popular and effective eyedrop instillation technique is illustrated in Figure 1. Ideally, 3-5 minutes should elapse between drop instillations in a given eye because of tear volume considerations. Once the drops have been instilled, effective mydriasis (pupillary diameter ≥ 6 mm) is usually achieved within 15-25 minutes.⁶ While waiting for the pupils to dilate, patients may be permitted to select their frames, sit in the waiting room, or remain in the examination chair. The optometrist can take advantage of the time required for dilation by starting on his next patient.

3. Postexamination considerations

It is good practice to advise each patient prior to mydriatic administration of the potential consequences of pupillary dilation and how long it will be before the effects wear off.^{5, 15} The most commonly encountered symptoms after mydriasis are blur, glare and photophobia. Blur is often greatest at near, but some distance blur may also be experienced due to the optical effects of a large pupil. The presence of refractive error can greatly influence how much blur a given patient will experience. For example, an uncorrected hyperope who habitually accommodates for distance will under cycloplegia find her entire visual environment blurred; whereas, the uncorrected myope may not notice any significant change in her vision at all. Glare can be very bothersome, especially at night and in patients with cataract or other media disturbances. Pho-

Figure 1.

Fraunfelder technique for applying topical solutions to the eye.

- The lower lid is gently pulled away at right angles to the plane of the head by the examiner's fingers.
- The drop is placed in the conjunctival sac without touching tissue or lashes.
- After waiting a moment to allow gravity to deliver the drop to the most dependent area of the fornix, the lid is then moved parallel to the plane of the head until it comes into contact with the globe.
- A portion of the drop is entrapped under the eyelid.

From Fraunfelder FT: "Extraocular Fluid Dynamics: How Best to Apply Topical Ocular Medication". *Trans Am Ophthalmol Soc.*, 74: 457 - 487, 1976.

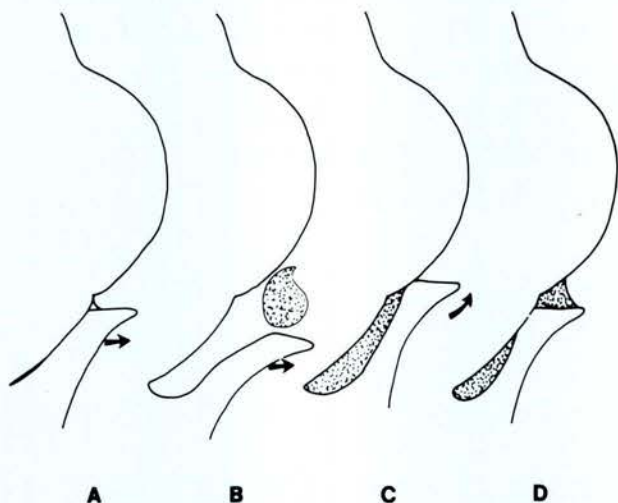


TABLE 3

Drugs that can Potentiate the Pressor Effects of Topical Ocular Phenylephrine

Tricyclic antidepressants

Amitriptyline HCL	Elavil
Amoxapine	Asendin
Clomipramine HCL	Anafranil
Desipramine HCL	Norpramin, Pertofrane
Doxepin HCL	Sinequan, Triadapin
Imipramine HCL	Tofranil
Maprotiline HCL	Ludiomil
Nortriptyline HCL	Aventyl
Protriptyline HCL	Triptil
Trimipramine	Surmontil

Monoamine Oxidase Inhibitors

Isocarboxazid	Marplan
Phenelzine sulfate	Nardil
Tranylcypromine sulfate	Parnate

tophobia is a natural reaction to bright light. This problem is best managed with sunglasses; disposable post-mydriatic sunglasses are available for this purpose.⁸ Using tropicamide and phenylephrine in combination, pupil size will return to normal in approximately 6 hours,⁹ and cycloplegia lasts about 60 minutes.¹⁰ Whenever it is anticipated that a patient may have difficulty driving home fol-

It is good practice to advise each patient prior to mydriatic administration of the potential consequences of pupillary dilation and how long it will be before the effects wear off.

lowing the examination, suggest that she have someone accompany her to the office who can drive her home afterward. The use of pilocarpine to reverse pupillary dilation for symptomatic purposes is potentially dangerous and usually ineffective.¹⁶

Special Considerations

When properly performed, pupillary dilation is a safe procedure with relatively few potential complications.¹⁷ The following circumstances, however, require that special precautions be taken: a) patients with a history of cardiovascular or cerebrovascular disease, b) the presence of a shallow anterior chamber angle, and c) the presence of an intraocular lens implant.

1. Phenylephrine Guidelines

Phenylephrine - even at the 2.5% concentration - should be used with caution in patients at risk for developing cardiovascular side effects from its use. It has been reported that patients with a history of cardiovascular or cerebrovascular disease; those using atropine, tricyclic antidepressants, or monoamine oxidase (MAO) inhibitors; and infants are at risk.¹³ Guidelines for the use of topical 2.5% phenylephrine are presented in Table 2. A listing of tricy-

a. Post-mydriatic spectacles are available from Bernell Corporation, 750 Lincolnway East, South Bend, Indiana 46634-4637. Telephone (219) 234-3200.

TABLE 4

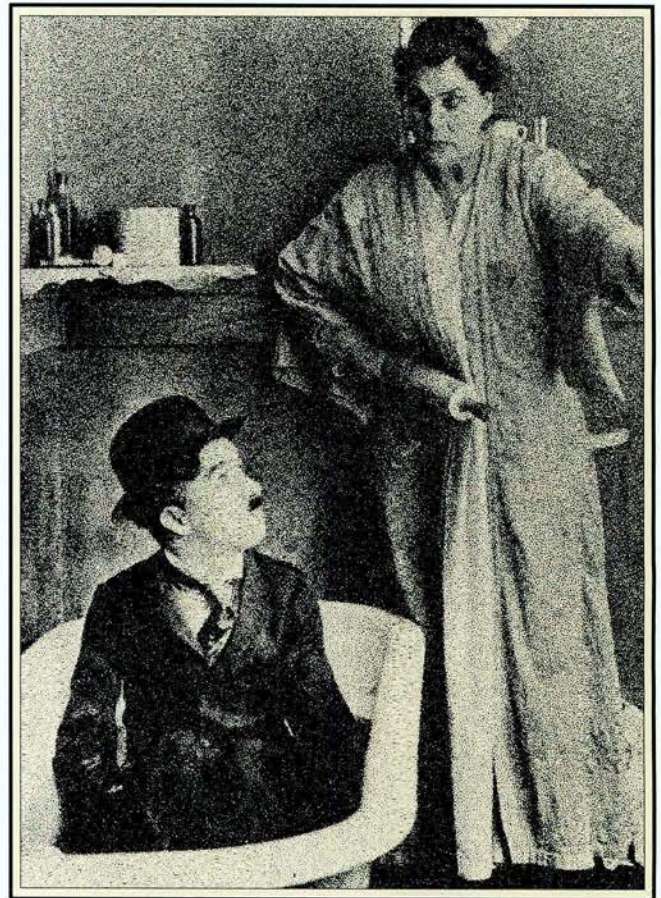
How to Perform the Prone Dark Room Provocative Test (PDRP)

1. You need a room which can be made completely dark, a table, bench or other support for the patient's head, and a tonometer (preferable a Perkins' hand-held instrument).
2. Instruct the patient on test protocol: emphasize the importance of staying awake during the test and explain the need to **rapidly** obtain pressure measurements at the conclusion of the test.
3. Obtain baseline IOP readings with the same tonometer that you will be using at the end of the test.
4. Seat the patient with his head down on a cushioned table, his face should be parallel to the floor (prone position) with the weight of his head supported on his forehead; no pressure should be placed on the eyes. A loose blindfold may be placed over the eyes if the room cannot be made completely dark, but it is probably best to simply have the patient keep his eyes closed. Arrange your instruments so that they are at the ready for the second set of readings.
5. Turn off the lights. The patient should remain in the dark, face down, for one hour. A radio and frequent calls through the closed door will help to keep the patient awake.
6. Return to the darkened room after one hour and allow yourself to dark adapt.
7. Perform tonometry as quickly as possible after the patient raises his head without exposing the patient to any unnecessary light. Because the IOP will start to fall once the head is elevated and the eye is exposed to light, it is very important to take the readings in the dark and as quickly as possible. The value of patient instruction, instrument preparation prior to reentering the dark room and examiner dark adaptation cannot be overemphasized.
8. Once the readings have been obtained the room lights may be turned on.
9. A rise in pressure of 8 mmhg or more in one or both eyes constitutes a positive result. Asymmetric rise in pressure between the two eyes is also suggestive of angle-closure.
10. The PDRP is the most physiologic, the most easily reversed, and hence the safest of all provocative tests for angle-closure glaucoma. Usually the pupil becomes miotic and the angle opens as soon as light strikes the eye.¹⁹

clic antidepressants and MAO inhibitors (both are used in the treatment of depression) is presented in Table 3. Because of sympathetic denervation hypersensitivity in patients with idiopathic orthostatic hypotension, insulin-dependent diabetes, and those taking adrenergic blocking agents, Bartlett⁶ suggest using either tropicamide alone or in combination with 1.0% hydroxyamphetamine in these individuals to avoid potential cardiovascular effects. He also cautions against the use of any adrenergic agent in patients with hyperthyroidism due to their increased sensitivity to circulating catecholamines.

2. Shallow anterior chamber angle

When a patient has an anterior chamber angle of van Herick grade 2 or less, special precautions are needed to avoid inducing angle-closure glaucoma. Although dangerously narrow anterior chamber angles are rare, with reports ranging between less than 2% up to about 6% of the population¹⁸, they should be identified as occludable before mydriatics are instilled. One approach to the management of such patients is as follows:



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Figure 2.

Diagrammatic representation of angle grading.

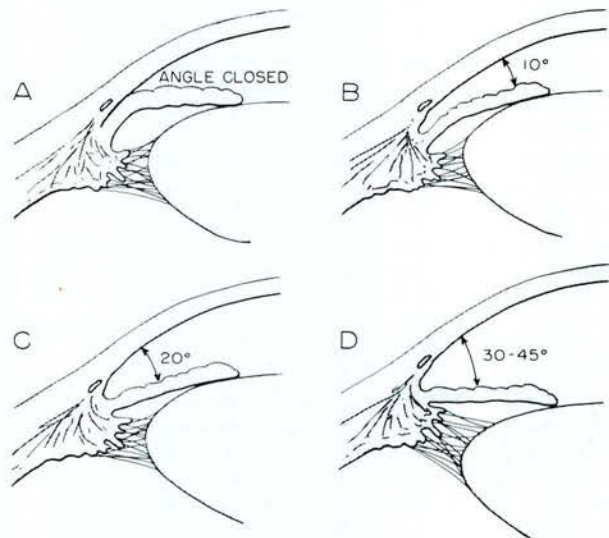
A. The iris is pushed forward completely occluding the chamber angle. This is the appearance during pupillary block angle-closure glaucoma.

B. This angle is narrow yet open, and at 10° would be grade 1. An angle this narrow would be susceptible to closure.

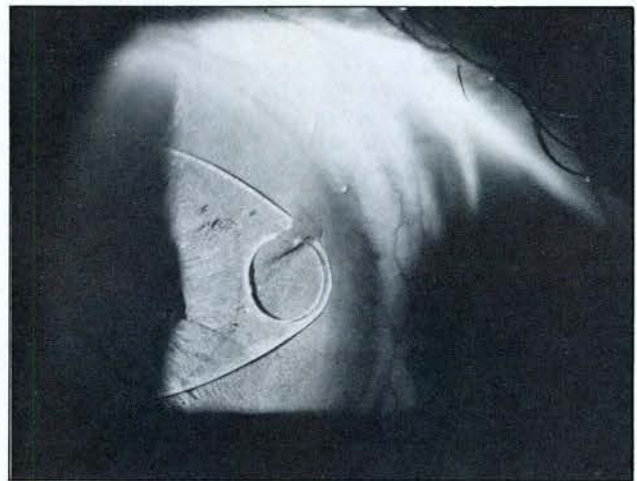
C. A safer angle, open to approximately 20° , this angle would be grade 2. Angles of grade 2 or less are considered capable of closure.

D. This is the most common anatomic appearance, a wide open angle. Angles of this configuration are grade 3 or 4 and are judged to be incapable of closure.

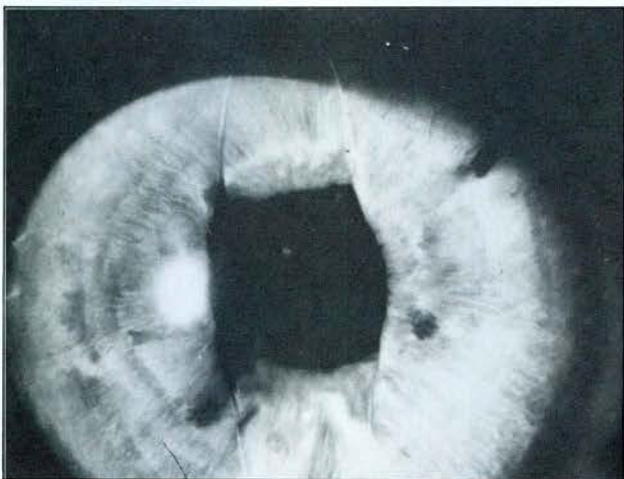
From Lichter PR: "Gonioscopy", Clinical Ophthalmology. Ed., T.D. Duane. Philadelphia: Harper & Row, 1986, Volume 3, Chap. 44.

**Figure 3.**
Iris-supported implants.

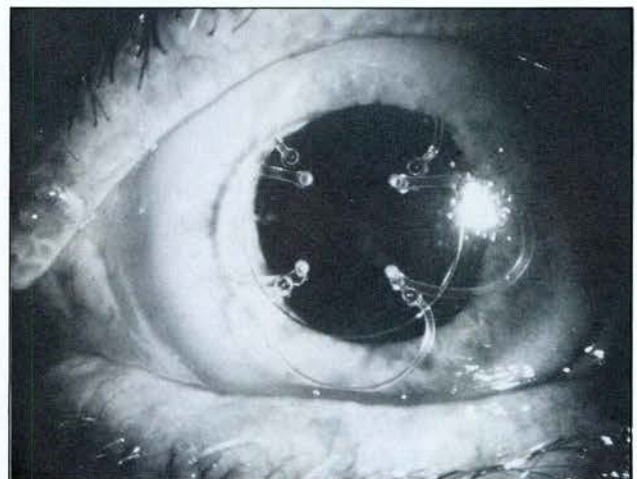
A. This iris-supported implant is attached to the anterior surface of the iris.



B. The same implant in figure 3a at higher magnification.



C. Typical presentation of a 4-loop implant. Note the square-shaped pupil which this lens produces.



D. A 4-loop implant dislocated into the anterior chamber. Surgery is required to correct this condition.

TABLE 5

Medical Treatment of Acute Angle-closure Glaucoma

1. The goals of medical treatment of acute angle-closure glaucoma are two-fold: first to lower the intraocular pressure and second to open the anterior chamber angle.
2. Pilocarpine is capable of achieving both of the above stated goals. If the ocular tension is relatively low (less than 40 mmhg) and there are no complicating factors, such as posterior or peripheral synechia, then pilocarpine alone may be sufficient to break the attack.²⁶ This should be the case in most iatrogenic attacks where a narrow angle has been recognized prior to pupillary dilation and the development of angle-closure is quickly recognized.
3. When the intraocular pressure is above 50 - 60 mmhg, measures must be taken to first lower the intraocular pressure before pilocarpine can be used to open the angle. Systemic osmotic agents such as glycerol and isosorbide are recommended for this purpose due to their ability to lower even the highest intraocular pressure to an acceptable level in a very brief period of time, because osmotics have a relatively short duration of action, other agents, such as acetazolamide (diamox) and topical beta-blockers (eg. timolol), may be used in combination with osmotics to maintain normal intraocular pressure until pilocarpine can successfully open the angle.

4. Agents and their recommended dosages for acute angle-closure glaucoma:^{19,20}

2% pilocarpine

Instill 2 drops initially, then 1 drop every 15 - 30 minutes until the attack is broken.

Systemic osmotics

- a) Glycerol 50% solution 1 ml/lb body weight. Served over ice with fruit juice. Entire dose should be consumed within 5 minutes. Nothing by mouth for at least 2 hours thereafter. Glycerol should not be given to diabetics.
- b) Isosorbide 45% solution 1.5 ml/lb body weight. may be used in lieu of glycerol.
- c) IV mannitol 20% solution 1.5% g/kg body weight, may be substituted if the patient is too nauseated to accept oral medication.

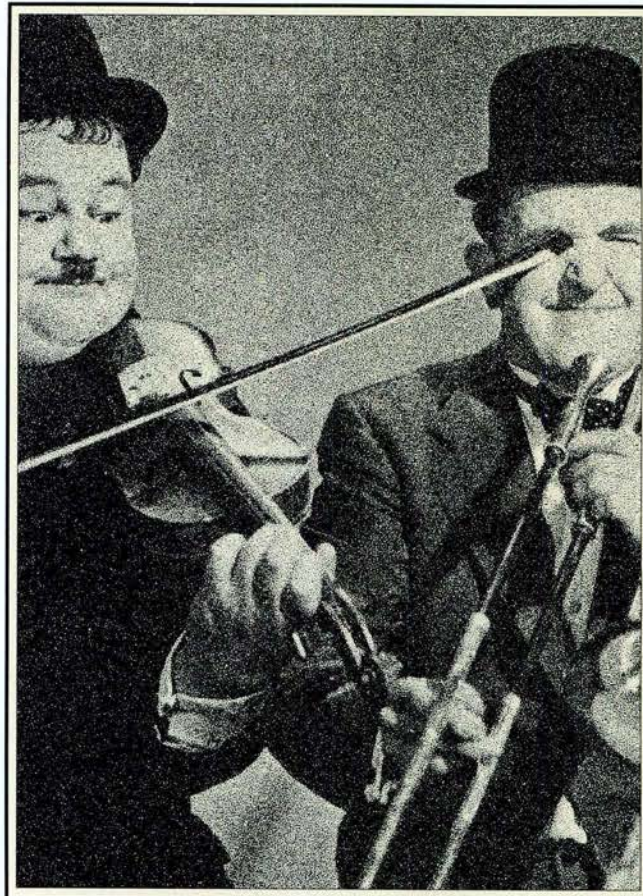
Acetazolamide 500 mg

May be administered PO, IM, OR IV

0.5% timolol

Instill 1-2 drops initially, then 1 drop every 12 hours until surgery.

- A. *Perform gonioscopy* to confirm that the angle appears occludable (Figure 2). If the angle appears incapable of closure (grades 3 and 4) then proceed with dilation. If, on the other hand, gonioscopy confirms the presence of a narrow angle, dilation is deferred until a prone dark room provocative test is performed.
- B. *The prone dark room provocative test (PDRP)* is a useful means of determining whether or not a given patient is at risk for developing angle-closure glaucoma¹⁹ (Table 4). A positive PDRP indicates the need for a prophylactic laser iridotomy to guard against angle-closure glaucoma.²⁰ If the PDRP is negative, dilation may be performed using 0.5% tropicamide.⁶ When the results are "borderline", consider dilating only one eye initially. Once it is clear that the first eye is not going to develop angle-closure, the second eye may be dilated. To insure that appropriate treatment is promptly instituted should angle-closure occur, have the narrow-angle patient remain in the office until the risk has



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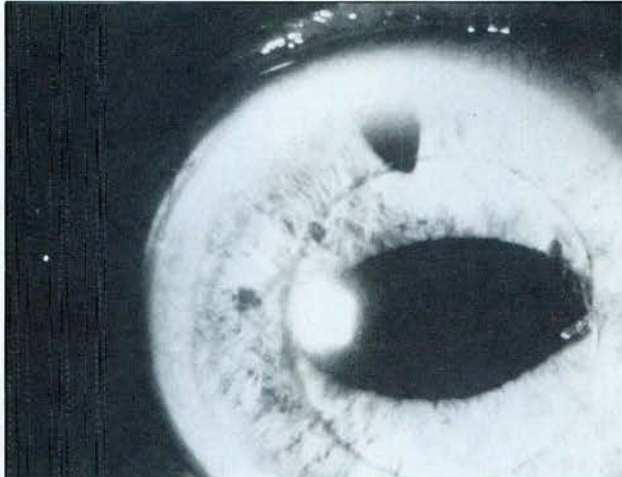
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Figure 4.**Pupil capture phenomenon.**

This posterior chamber implant has become totally entrapped by the pupil such that only the haptics remain in the posterior chamber. The pupil assumes a "cat's eye" configuration. Pupil capture is rare now that most posterior chamber implants have angulated haptics.



passed. Mapstone²¹ reports that when angle-closure secondary to tropicamide-induced mydriasis occurs, it does so within one hour of drop instillation. The medical treatment of acute angle-closure glaucoma is summarized in Table 5.

3. Intraocular Lens Implants

Most patients with modern intraocular lens implants (IOLs) may be safely dilated.²² Many early lens design, however, use the iris for support and require a normal-sized pupil for proper positioning.

Because mydriasis may cause iris-supported lenses to dislocate, pupillary dilation is not routinely performed in these eyes.

Because mydriasis may cause iris-supported lenses to dislocate, pupillary dilation is not routinely performed in these eyes (Figure 3). Dislocation is not a problem with anterior or posterior chamber implants²³, but posterior chamber lenses may become entrapped within the dilated pupil.²⁴ This so-called "pupil capture" phenomenon refers to a condition wherein the implant straddles the pupil, partially in the anterior chamber and partially in the posterior chamber (Figure 4). This is primarily a cosmetic problem, rarely causing significant visual effects.^{24, 25} To minimize the risk of entrapment, Bartlett⁶ suggests reversing the mydriasis with pilocarpine while the patient remains in office until the pupil is smaller than the optic of the IOL, and hence the risk of entrapment has passed. Pupil capture is rare now that most posterior chamber IOLs have haptic loops inclined 10 degrees forward from the optic.²⁵ These lenses position deep in the posterior

chamber well away from the pupillary margin. Should pupil capture occur, the eye may be redilated and the patient placed in a prone position while the mydriasis is again reversed with pilocarpine.⁶ In this way gravity will usually prevent re-entrapment.

Summary

A complete examination of the ocular fundus and media requires a widely dilated pupil. A standard predilation protocol should include a careful medical history and testing of visual acuity, biomicroscopy, pupils and tonometry. If neither the history nor the predilation testing contraindicate their use, 1.0% tropicamide in combination with 2.5% phenylephrine are suggested as the mydriatic agents of choice. Special consideration must be given to those patients who are at risk for the potential cardiovascular effects of phenylephrine, patients with shallow anterior chamber angles, and those with intraocular lens implants.

Acknowledgements

Dr. Hugh Jellie supplied Figures 3c, 3d, and 4. The author would like to thank Drs. Graham Strong and Tony Cullen for their assistance in the preparation of the manuscript.

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**The Canadian Optometric
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Invites
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**Le Fonds de fiducie pour les
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La *Revue canadienne d'optométrie* * *Canadian Journal of Optometry* est à la recherche d'un **rédacteur en chef** qui assumera l'entière responsabilité du contenu de cette publication dès le 1^{er} mars 1989.

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Les candidats intéressés sont invités à faire parvenir leur demande et leur curriculum vitae au plus tard le mardi 31 janvier 1989 au Président de l'Association canadienne des optométristes, Pièce 301, 1785, promenade Alta Vista, Ottawa (Ontario) K1G 3Y6.

Études comparative de deux méthodes de mesure de l'épaisseur de la cornée humaine

C. Giasson*
D. Forthomme**

Abstract

The central corneal thickness measured by 2 methods is compared in 31 normal subjects. At their 2 required visits, corneal thickness is evaluated by an electronic and an ultrasonic method. Reliability is demonstrated by an analysis of variance between repeated measurements for the electronic digital and the Humphrey ultrasonic pachometers. On the whole, the former reveals a systematic right-left difference, the left cornea being significantly thicker. A very high correlation coefficient is obtained between the two methods and, moreover, the result obtained for the right eye between these two methods is not significantly different.

Introduction

On appelle pachymétrie la mesure de l'épaisseur cornéenne. Son intérêt clinique résulte de la constatation suivante: quand le gonflement cornéen se produit, seule l'épaisseur du tissu augmente¹. On peut donc, par des mesures pachymétriques répétées évaluer indirectement l'hydratation de la cornée². La pachymétrie permet d'apprécier la santé oculaire chez le porteur de lentilles cornéennes, et chez le malade après kératoplastie ou après chirurgie intraoculaire avec atteinte cornéenne. On l'utilisera aussi pour évaluer la progression de l'amincissement cornéen dans le kératocône.

Mais la nécessité de connaître l'épaisseur topographique de la cornée avant toute chi-

Résumé

L'épaisseur centrale de la cornée mesurée par deux méthodes fait l'objet de comparaison chez un échantillon de trente-et-un sujets normaux. À chacune des deux séances requises, la mesure pachymétrique s'obtient par l'entremise d'une méthode optique et ultrasonique. Une analyse de variance à mesures répétées démontre la fiabilité des procédés optique et ultrasonique. Le pachymètre optique révèle des différences systématiques selon le côté observé. Un coefficient de corrélation très important est observé entre les deux procédés et les mesures obtenues pour l'œil droit ne sont pas différentes de façon significative.

urgie réfractive a donné un nouvel essor à la pachymétrie. Les méthodes ultrasoniques, plus faciles à utiliser en salle d'opération ont été mises au point récemment, et seraient, selon les premières indications, moins dépendantes de l'observateur³.

Cette étude vise à vérifier la fidélité et la validité du pachymètre à ultrasons de Humphrey par comparaison avec les résultats obtenus avec une méthode optique bien connue.

Matériel et Méthodes

Le pachymètre électronique (fig. 1) modèle 6090⁴ utilise le dispositif de Haag-Streit⁵. Il se compose de deux lames de verre à faces parallèles placées l'une au-dessus de l'autre. La rotation de la lame supérieure qui est mobile permet le déplacement de la partie supérieure de l'image; l'alignement de l'endothélium de la section cornéenne supérieure avec l'épithélium de la section

inférieure, permettra d'établir, après étalonnage, l'épaisseur apparente de la cornée.

La société "Diagnostic Concept" a relié la lame mobile à un potentiomètre. Les variations de voltage que produit ce dernier sont donc fonction de l'épaisseur de la cornée une fois l'appareil calibré⁶.

Quant au pachymètre de Humphrey (fig. 2), il utilise les ondes ultrasoniques dans la détermination de l'épaisseur cornéenne. Ce sont des ondes de compression semblables aux ondes soniques, mais dont la fréquence est beaucoup plus élevée (15KHz et plus)⁷.

À l'interface de la face postérieure de la cornée et de l'humeur aqueuse, l'onde est réfléchiée et captée à nouveau par la même sonde. La mesure du temps écoulé entre l'émission de l'onde et sa réception permet le calcul de l'épaisseur de la cornée, la vitesse sonique dans le milieu considéré étant connue. Cette dernière est approximative puisqu'elle est exécutée sur des cornées de cadavres. Diverses études la situent entre 1502 et 1639 m/sec^{8,9}. Avec le pachymètre à ultrasons de Humphrey: le film lacrymal est suffisant pour assurer le couplage de la sonde à la cornée.

Les Méthodes

L'examen de chacun des sujets se répartit sur deux visites à un même moment de la journée pour éviter la contamination possible des résultats par la variation diurne. Les sujets sont d'abord installés au pachymètre électronique. Le sujet fixe monoculairement la diode de fixation centrale et dix mesures sont prises pour chaque œil.

Le sujet est ensuite allongé et regarde droit devant lui. Après l'anesthésie de la cornée à la proparacaine, la sonde du pachymètre à ultrasons est appliquée perpendiculairement au centre de la cornée à cinq reprises.

Trente-et-un sujets sont examinés de cette

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façon à l'automne 1986. Ils sont tous de sexe masculin puisque la possibilité de variation cyclique chez la femme est controversée, ce qui l'exclut de la plupart des études pachymétriques^{10,11,12}. Chacun a une fixation centrale et ne présente pas de pathologie active du segment antérieur. Les sujets porteurs de lentilles cornéennes ne les ont pas portées depuis au moins un mois.

Les Résultats

Les tableaux I et II présentent de façon respective pour l'ensemble des sujets les moyennes et les écarts-types pour le pachymètre électronique et le pachymètre à ultrasons.

La consistance des résultats est vérifiée pour chaque instrument, par une analyse de variance à mesures répétées pour chaque oeil et à chacune des visites. Pour chaque sujet, il n'est pas possible de trouver de différences significatives entre les diverses mesures qui ont produit les moyennes. Une série de mesures consécutives est ensuite divisée en deux demi-séries et le coefficient de corrélation obtenu entre les deux révèle un coefficient d'équivalence d'au moins .9188. À partir de ce dernier, il est possible d'obtenir par la formule de Spearman-Brown une évaluation de la consistance interne de l'ensemble. Au minimum, cette dernière s'élève à .9577. Le tableau III présente les résultats de l'analyse de variance dans le cas du pachymètre électronique pour l'oeil gauche à la première visite; et le tableau IV, l'établit pour le pachymètre ultrasonique dans les mêmes conditions. L'importance des coefficients observés s'avère du même ordre de grandeur dans les autres conditions testées (oeil droit/première et seconde visite; oeil gauche/seconde visite) et permet de conclure à la consistance des résultats dans le reste des cas. Les moyennes représentent bien la distribution de ces résultats et elles sont fiables.

Au pachymètre électronique, on observe, à l'analyse des moyennes de toutes les mesures oeil par oeil, une différence statistique significative là où l'oeil gauche est plus épais ($t = -2.73$; $dl = 30$; $p = 0.010$) (tableau V). Le pachymètre ultrasonique ne détecte pas de différence de mesure entre l'oeil droit et l'oeil gauche.

Les moyennes des moyennes et des écarts-types obtenues avec le pachymètre électronique sont comparées par un test t avec les résultats correspondants de la méthode ultrasonique. Du côté droit, les résultats sont statistiquement identiques ($t = 0,31$) mais du côté gauche, la méthode ultrasonique enregistre des moyennes glo-

TABEAU 1

Épaisseur moyenne de la cornée centrale (μm) obtenue avec le pachymètre électronique pour l'ensemble des 31 sujets. L'écart-type est aussi représenté.

ODV1*	OSV1*	ODV2**	OSV2**
544,0 + 28,2	546,8 + 30,3	538,0 + 26,7	544,0 + 27,4

V1*: première visite
V2**: seconde visite

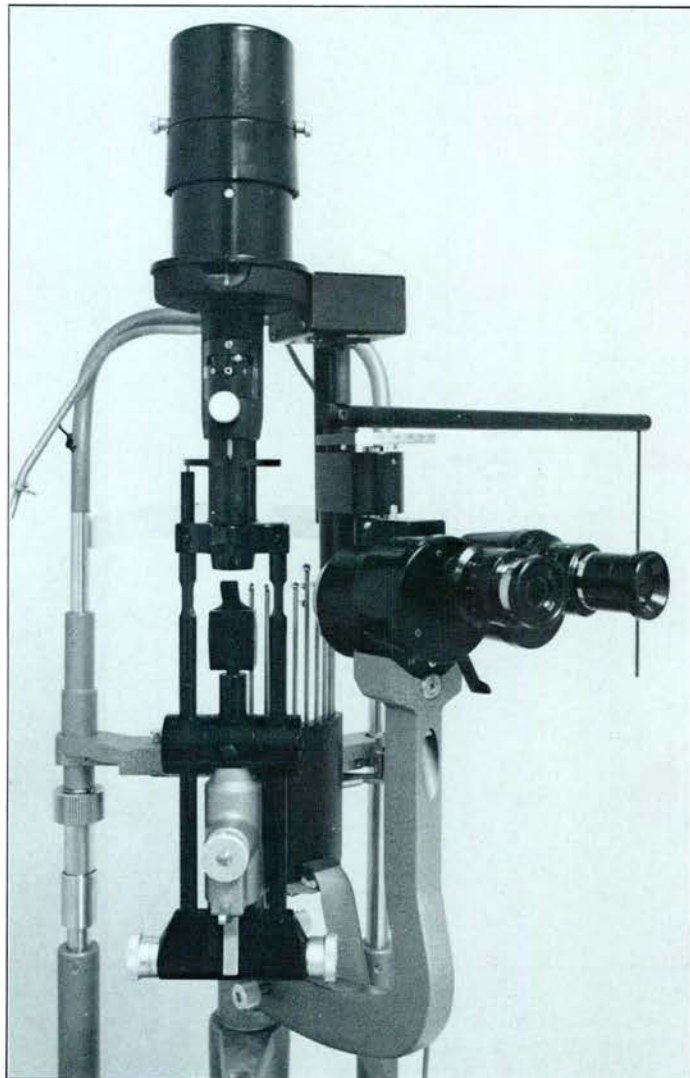
TABEAU 2

Épaisseur moyenne de la cornée centrale obtenue avec le pachymètre ultrasonique pour l'ensemble des 31 sujets. L'écart-type est aussi représenté.

ODV1	OSV1	ODV2	OSV2
541,6 + 29,4	539,2 + 28,9	541,4 + 30,0	539,5 + 29,5

Figure 1

Le pachymètre de Haag-Streit constitue l'unité de base du pachymètre électronique de "Diagnostic Concept". L'oculaire droit à fente et le potentiomètre (qui surmonte l'échelle graduée) sont visibles sur la photographie.



bales significativement plus faibles que la méthode électronique ($t = 3,46$) (tableau VI). L'écart-type moyen est, de façon significative, plus petit avec la méthode des ultrasons pour l'oeil droit ($t = 16,77$; $dl = 30$; $P < 0,000$) et pour l'oeil gauche ($t = 6,62$; $dl = 30$; $p < 0,000$) (Tableau VII).

Il n'est pas possible de s'assurer de la validité empirique des procédés, car l'épaisseur réelle des cornées considérées est inconnue. Il ne sera pas possible de prouver que le paramètre désiré est bien celui qu'on mesure. Tout au plus est-il possible d'étudier les variations d'un instrument en fonction des variations de l'autre, en réservant aux résultats du pachymètre électronique la variable explicative. Une analyse corrélationnelle précise le lien linéaire qui unit les moyennes obtenues par les deux pachymè-

Figure 2

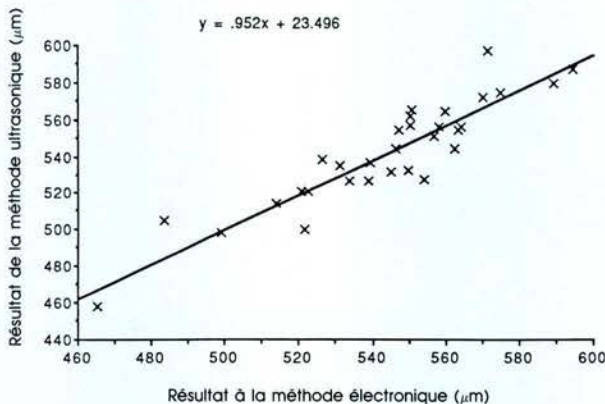
Le pachymètre 850 de Humphrey est un instrument qui utilise des pulsions d'ultrasons pour la mesure de l'épaisseur cornéenne. La sonde émettrice-réceptrice, qu'on aperçoit sur l'imprimante de l'instrument, mesurerait sur une surface de $1,5 \text{ mm}^2$.



Figure 3

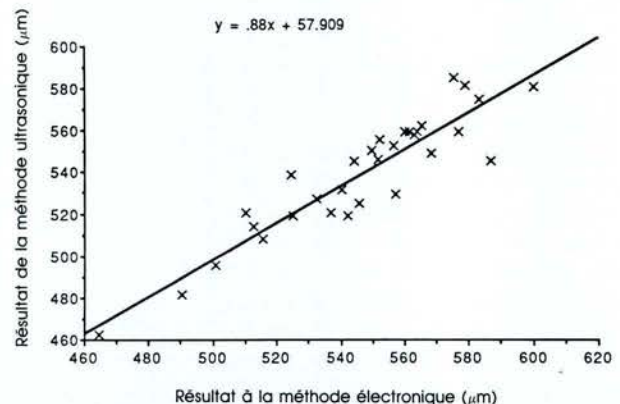
Épaisseur (en μm) de la cornée centrale mesurée avec le pachymètre ultrasonique en fonction de la mesure obtenue avec le pachymètre électronique pour le côté gauche à la première visite.

Figure 3a



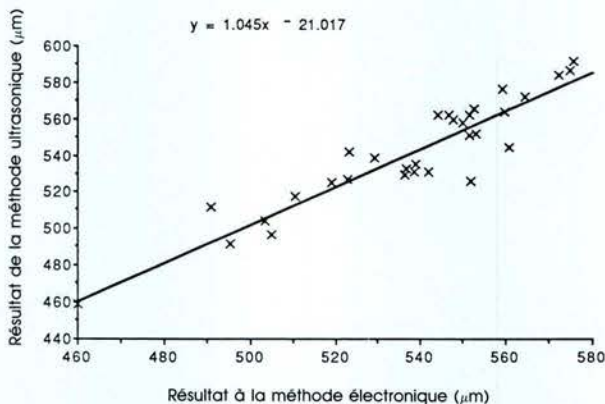
Droite de régression entre les résultats de la méthode ultrasonique en fonction des résultats de la méthode électronique (oeil droit, première visite)

Figure 3b



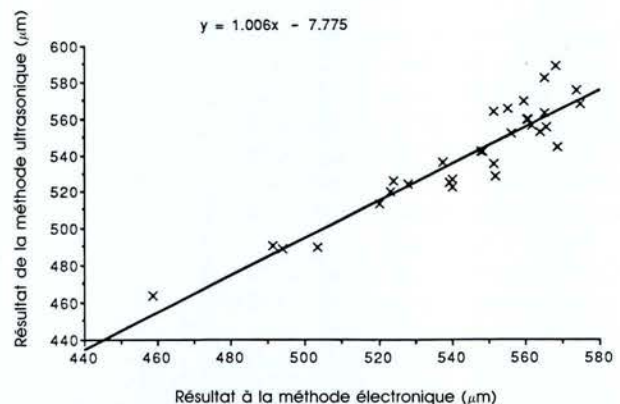
Droite de régression entre les résultats de la méthode ultrasonique en fonction des résultats de la méthode électronique (oeil gauche, première visite)

Figure 3c



Droite de régression entre les résultats de la méthode ultrasonique en fonction des résultats de la méthode électronique (oeil droit, seconde visite)

Figure 3d



Droite de régression entre les résultats de la méthode ultrasonique en fonction des résultats de la méthode électronique (oeil gauche, seconde visite)

tres pour chaque oeil et à chacune des visites. Les résultats de l'analyse de variance sont présentés pour le pachymètre électronique au tableau VIII. Le tableau IX résume les résultats pour les autres conditions. Dans chaque cas, la variance s'avère très significative puisque le rapport F doit être plus grand que $F_{0,05;1,29} = 4,18$ pour un niveau de signification $\alpha = .05$. On y retrouvera aussi l'équation de la droite de régression obtenue par la méthode des moindres carrés. Cette relation permet d'évaluer la

mesure moyenne obtenue au pachymètre ultrasonique, celle de la méthode électronique étant connue. Le coefficient de corrélation est au minimum de .91567, alors que le coefficient d'explication précise qu'au moins 83,8% de la variation dans Y est expliquée par la droite de régression.

La figure 3 illustre la relation entre les mesures obtenues par les ultrasons en ordonnée, en fonction de celles que fournit la méthode électronique en abscisse, pour le côté gauche à la première visite.

TABLEAU III

Analyse de variance: résultats pour les données de la méthode électronique du côté gauche à la première visite.

Source	dl	MC	F
Entre les sujets	28	9432,13	
Parmi les sujets	261	195,85	
Entre les mesures	9	199,20	1,0177*
Résiduelle	252	195,73	
Totale	289	1090,72	

*p = ,4262 N = 29 cas r = ,9188 $r_{gsh} = ,9562$ $r_{sb} = ,9577$

r_{gsh} : coefficient de corrélation de Guttman entre demi-séries.

r_{sb} : coefficient de corrélation de Spearman-Brown.

TABLEAU IV

Analyse de variance: résultats pour les données de la méthode ultrasonique du côté gauche à la première visite.

Source	dl	MC	F
Entre les sujets	30	4189,70	
Parmi les sujets	124	29,13	
Entre les mesures	4	22,95	,7821*
Résiduelle	120	29,33	
Totale	154	839,63	

*p = ,5390 N = 31 cas r = ,9802 $r_{gsh} = ,9441$ $r_{sba} = ,9904$

r_{gsh} : coefficient de corrélation de Guttman entre demi-séries.

r_{sb} : coefficient de corrélation de Spearman-Brown.

r_{sbs} : r_{sb} ajusté pour des demi-séries de longueur inégale.

TABLEAU V

Test t entre les moyennes des mesures en μm de l'oeil droit et gauche pour chacune des méthodes

	OD	OS	t	dl	P
Electronique	540,9	545,4	-2,73	30	,010*
Ultrasonique	541,5	539,3	1,75	30	,090

*p < 0,05

O.D. est l'oeil droit, O.S., le gauche; t, dl et p sont respectivement la cote du test de Student, les degrés de liberté et la probabilité correspondante.

Discussion

Les pachymètres électronique et ultrasonique donnent des données consistantes dans une série de mesures. La moyenne des moyennes qu'ils fournissent ($540 \mu\text{m}$) se situe dans l'intervalle de confiance de Maurice¹³: $0,52 + 0,04 \text{ mm}$. L'écart-type est ici inférieur, et vaut $30 \mu\text{m}$ avec l'une ou l'autre des deux méthodes utilisées.

La variation à l'intérieur d'une série de mesures (l'écart-type moyen) du pachymètre électronique ($12 \mu\text{m}$) est de plus du double de celle obtenue par la méthode ultrasonique ($5 \mu\text{m}$).

Visite par visite, il n'y a jamais de différence significative entre les méthodes pour le côté droit. Dans l'oeil gauche, les mesures sont significativement plus petites avec le procédé ultrasonique. De plus, avec la méthode électronique, en moyenne, l'épaisseur de la cornée gauche semble plus épaisse que celle de la cornée droite. Cette différence systématique selon le côté n'est pas observée avec l'autre instrument, et ne s'explique pas par une différence réelle d'épaisseur de la cornée. Ce phénomène, bien décrit dans la littérature spécialisée^{3,14,15} intervient lorsque la fixation est en cause. Divers dispositifs ont été proposés pour éviter cette erreur systématique qui se produit lorsque le système n'est pas parfaitement perpendiculaire à la cornée mesurée^{5,16}. Alors que la mesure de l'oeil droit est exécutée à toutes fins pratiques le long de la normale à la cornée, l'axe pachymétrique s'écarte de l'axe pupillaire et de la perpendicularité lors de la mesure de l'oeil gauche. Son obliquité entraîne une valeur plus importante de façon significative.

Cette étude supporte les conclusions de d'autres études^{15,17} selon lesquelles le coefficient de corrélation entre les méthodes optique et ultrasonique est très important.

Le pachymètre à ultrasons de Humphrey s'est avéré au cours de cette étude un instrument précis, dont les valeurs sont constantes. Puisque les mesures ne sont pas différentes de celles du pachymètre électronique du côté où ce dernier mesure le plus normalement à la surface, la vitesse sonique choisie par le fabricant semble appropriée. L'usage de la méthode ultrasonique nécessite toutefois l'anesthésie de la cornée, à cause du contact requis avec la sonde.

La localisation du site cornéen mesuré est plus approximative qu'avec la méthode optique, où le système grossissant nous est utile. Cet instrument présenterait cependant un avantage marqué sur la méthode optique dans le cas de cornées opaques, et lors

TABLEAU VI

Test t entre les mesures moyennes en μm des visites 1 et 2 des méthodes ultrasoniques et électronique.

	Electronique	Ultrasonique	t	dl	p
OD	540,9	541,5	,31	30	,756
OS	545,4	539,3	3,46	30	,002*

O.D. est l'oeil droit, O.S., le gauche; t, dl et p sont respectivement la cote du test de Student, les degrés de liberté et la probabilité correspondante.

TABLEAU VII

Test t entre les écarts-types en μm des mesures des visites 1 et 2 entre les méthodes.

	Electronique	Ultrasonique	t	dl	p
OD	13,1	5,5	- 16,77	30	,000*
OS	13,5	6,4	- 6,62	30	,000*

O.D. est l'oeil droit, O.S., le gauche; t, dl et p sont respectivement la cote du test de Student, les degrés de liberté et la probabilité correspondante.

TABLEAU VIII

Table de variance: régression des mesures de la méthode ultrasonique en fonction de la méthode électronique pour l'oeil droit à la première visite.

Source de variation	SC	dl	CM	F
Variation totale corrigée	25 883,628	30		
Dûe à la régression	21701,98650	1	21701,98650	150,50490
Résiduelle	4181,64188	29	144,19455	
$F_{0,05;1,29} = 4.18$ $y = 23.5 + 0,95X$ $r^2 = ,83844$ $r = ,91567$ $r_a^2 = ,83287$				

TABLEAU IX

Résumé de la table de variance: régression des mesures de la méthode ultrasonique en fonction de la méthode électronique:

l'oeil gauche à la première visite:

$$F_{0,05;1,29} = 4.18 \quad Y = 57,91 + 0,88X \quad r = ,84959 \quad r = ,92173 \quad r_a^2 = ,84441$$

l'oeil droit à la seconde visite:

$$F_{0,05;1,29} = 4.18 \quad Y = -21,02 + 1,04X \quad r^2 = ,86556 \quad r = ,93036 \quad r_a^2 = ,86093$$

l'oeil gauche à la seconde visite:

$$F_{0,05;1,29} = 4.18 \quad Y = -7,77 + 1,01X \quad r^2 = ,87117 \quad r = ,93336 \quad r_a^2 = ,86672$$

d'expériences comportant plusieurs observateurs.

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Visual Performance for Chromatic Displays

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Abstract

Video Display Units (VDUs) have been incorporated in various workstations over the past few years. Their widespread use has been accompanied by many symptoms of general and visual discomfort. On the visual side, several studies have implicated inaccuracies in the accommodative system as the possible cause of VDU related visual fatigue. Further, the use of color-coded information in modern electro-optical displays may stress the focussing system even more because of the chromatic aberration present in the optics of the human eye. In view of the popularity of VDUs and their possible implication in user's visual fatigue, we examined the effect of VDU displayed colored stimuli on the visual neural and accommodative system of the human eye. Twenty paid volunteers in a 22 to 35 year age category participated in the present study. Stimuli were presented on a high resolution RGB monitor, at a 40 cm observation distance and varied in color, size and degree of retinal defocus. Visually Evoked Potential (VEP) and laser optometer techniques were used to assess visual neural and accommodative performance. Both measures isolated differential effects of these stimuli characteristics on the visual system. Results are presented and discussed as they relate to electro-optical display design.

Résumé

Les appareils à écran d'affichage ont envahi divers postes de travail, ces dernières années. L'élargissement de leur utilisation a donné lieu à divers symptômes de gêne générale et visuelle. En ce qui a trait à la vision, plusieurs études laissent croire que des imprécisions du système d'accommodement pourraient être la cause de la fatigue visuelle liée aux terminaux à écran. De plus, l'utilisation du codage couleurs dans les dispositifs modernes d'affichage électro-optique exigent peut-être encore davantage du système de mise au point, en raison des aberrations chromatiques présentes dans l'optique de l'œil humain. Compte tenu de la popularité des appareils à écran d'affichage et de leur rôle possible dans la fatigue visuelle des utilisateurs, nous avons étudié des effets de stimuli de couleurs (à l'écran) sur le système neurologique et l'accommodement de l'œil humain. Ont pris part à l'étude 20 volontaires rémunérés, de 22 à 35 ans. Les stimuli lumineux ont été présentés sur un écran RVB haute définition à une distance de 40 cm de l'observateur, avec variation des couleurs, de la taille et du degré de défocalisation rétinienne. À l'aide des techniques d'optométrie laser et de potentiels évoqués visuels, nous avons évalué le rendement neurologique visuel et l'accommodement. Les deux méthodes de relevés ont permis d'isoler des effets différentiels de ces stimuli caractéristiques du système visuel. Les auteurs présentent et analysent les résultats du point de vue de la conception des écrans d'affichage électro-optiques.

Introduction

Within the last ten years or so, the Video Display Unit (VDU) has become an essential tool of communication in many types of working environments. With the arrival of this modern technology, workstations had to be redesigned to meet the ergonomic requirements of this electro-optical communication medium^{1,2,3}. New VDU users were required not only to learn the proper use of VDUs, but also to modify their posture and their physical environment to work comfortably and efficiently. This adaptation took place gradually, and not without a variety of symptoms of general discomfort and fatigue. On the visual side, studies have reported various symptoms of visual distress associated with VDU use, including eyestrain, headaches, double vision, and blur^{3,4,5}. Numerous investigations have been carried out attempting to quantify these subjective symptoms, and relate them to the impairment of specific visual function(s). Some studies have demonstrated quantifiable changes in visual function specifically after work on VDUs, while others have shown that similar dysfunctions also occur on hardcopy material^{6,7,8}. Most studies reporting some form of visual distress after VDU use conclude that alterations in the focussing function of the eye are likely causes of the visual fatigue and blur so often reported by VDU users. The types of measurable deficiencies in the accommodative system that have been reported include; a delay in the time required to focus from near to far objects and vice versa^{9,10}, a decrease in the amplitude of accommodation¹¹, an increase in the dark focus of accommodation towards more myopia¹², a decrease in the slope of the lead/lag accommodative function¹²,

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and a transient reduction in visual acuity achievable at distance^{13,14}.

In addition to the various psychophysical methods used in these studies to investigate the accommodative system of the eye, there exists a unique, objective clinical procedure, the visual evoked potential (VEP), that can be used to assess focussing inaccuracies^{15,16}. The VEP is a bio-electrical signal recorded at the level of the occipital cortex, in response to specific visual stimuli. This electrical signal can provide information not only on the functional integrity of the visual pathways originating in the macular area of the retina and terminating in the visual cortex¹⁷, but also the pattern processing mechanisms of the visual system. The VEP is therefore sensitive to any changes in the clarity of the retinal image. When the VEP is applied to assess pattern visual stimuli presented on electro-optical displays, it provides an objective assessment of the responsivity of the afferent visual system to various display parameters, such as image sharpness, chromaticity, size, and luminance^{18,19}. In this regard, the VEP may be utilized as a neuro-visual meter optimizing the physical parameters of elements displayed on the screen for the human visual system.

There exists a unique, objective clinical procedure, the visual evoked potential (VEP), that can be used to assess focussing inaccuracies.

The present report describes the application of two different techniques, that were used to investigate the accommodative and visual neural performance for chromatic displays. The objective of the study was to determine if there was a differential neural and accommodative response to VDU displayed targets varying in color, size, and border sharpness. In the first phase of this study, we used the VEP to measure the visual neural responses to selected display parameters. In a second experiment, we measured the steady-state accommodative responses to stimuli with identical spatial, chromatic and luminance characteristics with a laser speckle optometer²⁰.

Materials and Methods

Twenty paid volunteers (10 females, 10 males) varying in age from 22 to 35 years (avg. 25.7 ± 3.66 yrs) participated in the present experiment. All sub-

jects were given a careful visual screening and determined to have good ocular health, 20/20 (6/6) or better monocular visual acuity for distant and nearpoint vision, normal phoria/fusional reserves relationships, stereoacuity of 40 arcsec or better, normal age-related monocular amplitudes of accommodation, a good signal-to-noise VEP ratio, and no color vision deficiencies as determined by the Ishihara and Farnsworth color vision plates. All experimental procedures employed in this study complied with the regulations of the Ethics Committee for human experimentation at the University of Waterloo. Subjects were informed of the nature of the testing procedures and were aware of their right to withdraw from the experiment at any point in time for whatever reason.

Measurements of neural performance

The recording of VEPs requires specific stimuli, such as reversing checkerboards or sinusoidal gratings, in order to elicit a distinguishable rhythmical cortical signal. In the present experiment, we used checkerboards reversing in counterphase, and displayed on a high resolution RGB monitor. The physical characteristics of these targets (chromaticity, size and luminance) were the same as for the alphanumeric used to assess the steady-state accommodative responses with the laser optometer, and were known to elicit a similar accommodative response. Thus, the results of VEP recordings could be compared to the psychophysical measurements of accommodation.

All stimuli were presented on a high resolution Hitachi RGB monitor (model HM-2719C-C-01) at a 40cm observation distance. This viewing distance was selected since it approximates the typical distance of most occupation nearpoint tasks. Shifts of gaze towards distracting peripheral targets were minimized by surrounding the monitor screen with a wide black collar. The checkerboards contained white/black, red/black, green/black or blue/black checks, subtending 14, 21 or 28 minarc at the ocular plane. Custom software allowed an auto-sequence presentation of the targets to facilitate experimental procedures and ensure that no stimulus presentation was omitted from testing. The autosequence displayed first the 14 minarc white/black, red/black, green/black and blue/black checks, followed by the 21 and 28 minarc checks in the same order of color presentation. Each stimulus was displayed on the screen for about 1 minute, long enough to elicit the associated VEP and average 50, 200msec epochs.

SPECTRAL CHARACTERISTICS OF BRIGHTNESS MATCHED COLORS

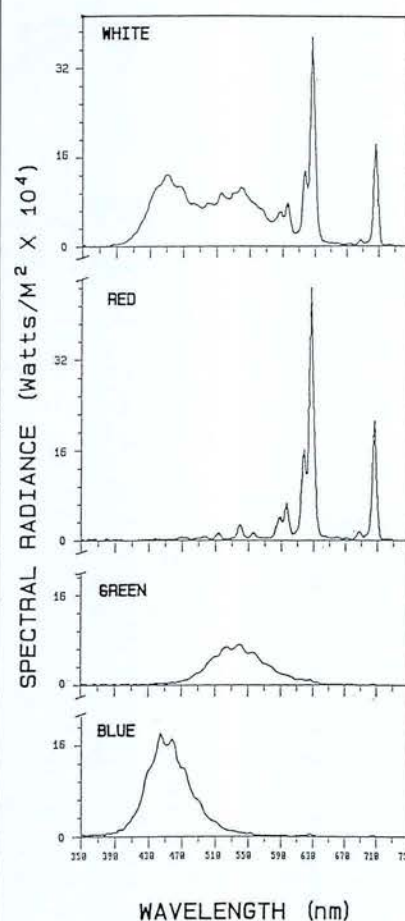


Figure 1
Spectral characteristics of brightness-matched white, red, green and blue colors displayed on the Hitachi RGB monitor. Peak emissions are centered at 626, 532 and 450nm for the red, green and blue respectively, with a half band width of 25, 80 and 70nm.

VEPs were first recorded with the subject wearing lenses for any existing refractive error, and then for three pre-determined levels of blur, simulating retinal defocus for the display screen. All VEPs were recorded in a same session to minimize within subject longitudinal variability in the neural response, and to ensure a constancy of electrode location. Each VEP test session typically lasted for about 1.25 hour, and subjects were allowed to relax as often as needed to minimize fatigue effects. White, red and green colors had been previously matched for brightness to blue by a standard psychophysical method of limits. The

spectral characteristics of the brightness-matched targets used in this study are presented in Figure 1. Ambient lighting at the monitor surface was maintained at 54 lux. Throughout the entire session, subjects were comfortably seated at the appropriate observation distance, and were required to look in the center of the screen, while maintaining the best possible focus of the test targets.

Figure 2 illustrates the standard procedure used to record the VEP. We used a 33×24 cm checkerboard, with checks reversing in counterphase at a frequency of 2 Hz. This reversal rate resulted in a transient pattern VEP. The active electrode was positioned on the scalp on the mid-sagittal line, about 2cm above the inion, while the reference electrode was located 5cm higher. The ground electrode was attached to the left earlobe. The active and reference electrodes were glued to the scalp with collodion, to ensure their stability during recording. A standard 5 V pulse generated by the software controlling the checkerboard reversals was used to synchronize the checkerboard reversal with a clinical averager (Nicolet CA-1000) of evoked potentials. Skin-electrode impedance was kept below 10 K Ω . Amplification of the evoked cortical signal was about 50K, and VEPs were filtered for a band pass between 1 and 30 Hz.

Measurements of accommodative performance

Figure 3 presents a schematic view of the laser speckle optometer used to measure steady-state accommodative responses. The light beam emitted from a 1 mW He-Ne laser (632.8nm) was diverged by a microscope eyepiece, and reflected from the front surface of a drum rotating at 1 rpm. The roughened surface of the drum allowed the formation of a speckle pattern, which was then refracted through an +8.00D Badal

The task of the subject was to maintain clear focus of the test target, and adjust the position of the drum to achieve a speckle pattern with a random movement or "boiling" pattern each time it appeared.

lens and directed to the subject's left eye via a beam splitter. The speckle pattern was then visually projected by the subject on the binocularly fixated VDU target. A rotating vane, placed between the microscope eye-

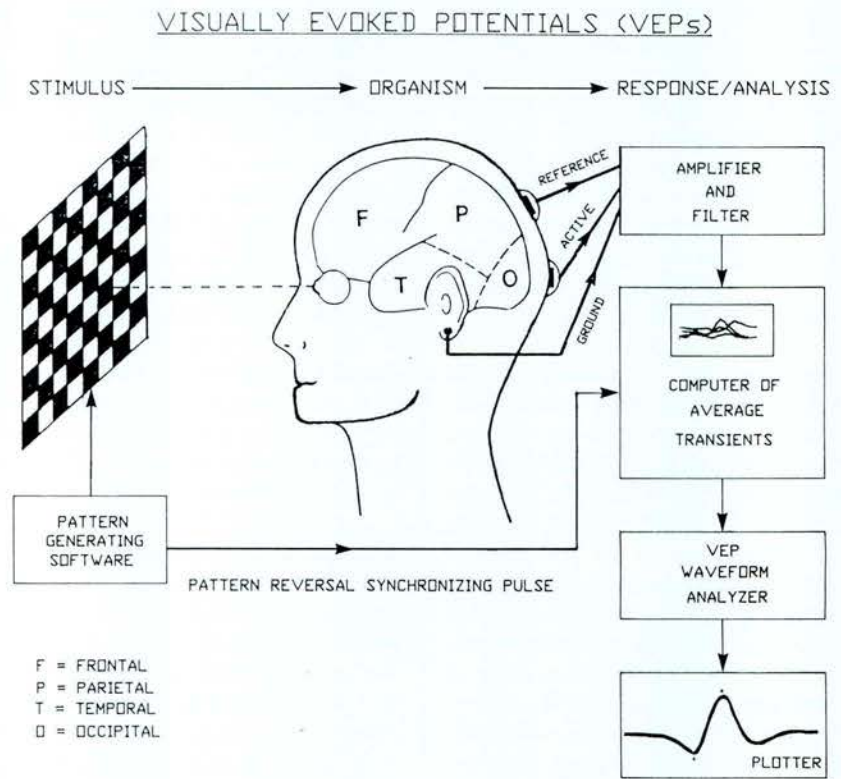


Figure 2

Schematic representation of the conventional method used to elicit and record the VEP. A checkerboard containing white/black, red/black, green/black or blue/black checks, reversing in counterphase at a frequency of 2Hz was used to elicit the VEP. This VEP signal was detected by scalp electrodes, amplified, filtered and averaged by a computer of average transients. All results were stored on floppy diskettes for later retrieval and analysis.

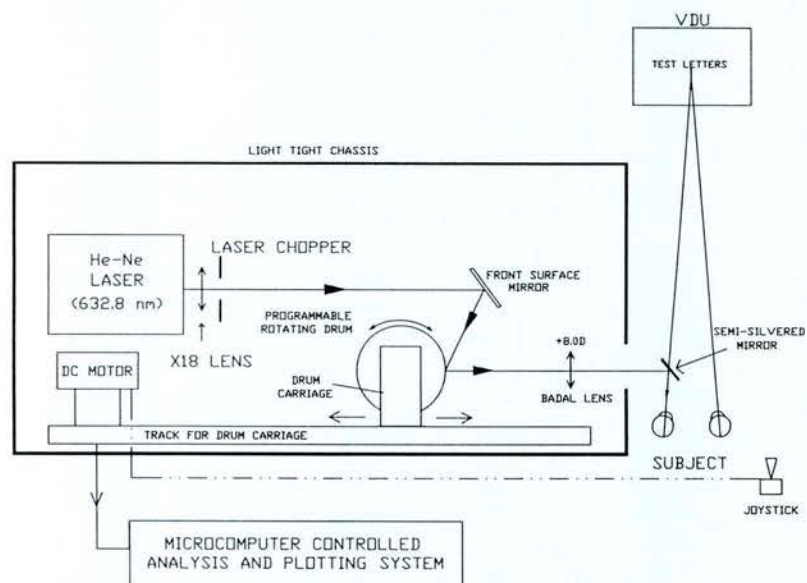


Figure 3

Schematic representation of the He-Ne laser optometer system used to measure the steady-state accommodative responses for VDU alpha-numerics. See text for operational details.

piece and the drum, ensured that the speckle pattern was exposed intermittently to monitor the accommodative response, and did not itself serve as a stimulus to accommodation. The distance of the drum from the Badal lens along a motorized platform was controlled by the subject with a remote joystick. Stability of the subject's head during accommodative measurements was ensured by a forehead and chin rest. The task of the subject was to maintain clear focus of the test target, and adjust the position of the drum to achieve a speckle pattern with a random movement or "boiling" pattern each time it appeared. If the speckles were seen to move upwards, the joystick was moved downwards in small steps until the boiling appearance of the speckles was achieved. If the speckle pattern was seen to move downwards, the joystick was moved upwards to attain the criterion boiling pattern. Thus, once this random speckle movement was obtained, a constant readjustment of the drum position was required by the subject to maintain the boiling appearance of the speckles, which indicated conjugacy of the retina and the plane of stationarity²¹ of the drum. A special electronic circuit periodically changed the direction of rotation of the drum to ensure alertness of the subject to the direction of speckle flow, and decrease adaptive adjustments of the joystick.

The laser optometer was interfaced with a computer and custom software which almost instantly converted the position of the drum from the Badal lens into diopters. The software program also took into account the position of the plane of stationarity in all conversions of drum-lens distance into diopter values.

The stimulus used for laser optometer measurements of accommodation was a text containing 3 lines of prose displayed in the center of the VDU screen. All other aspects of the selected stimuli, ambient illumination, autosequence presentation of targets etc. were identical to those described in the VEP section. In order to minimize reflected images from the monitor surface of laboratory items and testing instrumentation on the black background of the screen, the walls behind the observer were covered with black, matt cloth. During any measurement of accommodation, the computer program driving the text presentation was synchronized with the rotating vane of the laser optometer, triggering the presentation of a square black patch in the center of the text each time the speckle appeared on the screen. This was done to ensure uniformity of contrast between the red speckle pattern and the background across stimulus presen-

tations consisting of different colored targets. Each stimulus presentation was long enough to obtain a boiling speckle pattern and a full one minute recording of the accommodative response. Analog/digital circuitry sampled the drum position at 1.0 second intervals, yielding 60 measures of the accommodative response within a one minute viewing period. This time varied across subjects, but was set on average to 1.5 minutes. The speckle exposure time was adjusted for each subject²² and determined by the criteria of the ease of judging the direction of movement of the speckle pattern, and measures that gave the least overaccommodation and good repeatability of accommodative measurements. On average, a valid speckle exposure time was 400ms.

Blurring of test targets

All VEP and laser optometer measurements were performed with the subjects wearing lenses correcting any existing ametropia, as well as lenses inducing 3 increasing levels of blur. These blur levels were determined before the recording sessions and amounted to 20/20, 20/25 and 20/30 (6/6, 6/7.5 and 6/9) blur-out vision of high-contrast Snellen letters appropriately reduced for presentation at 40cm. Blurring was effected by positive spherical lenses positioned in front of the eyes in the spectacle plane.

Results

Neural performance

All VEPs recorded in the present study were analysed in their amplitude and timing characteristics. The amplitude of the evoked potential was measured as the voltage difference between the trough and the peak of the P-100 component of the transient VEP. A sample waveform of the transient pattern VEP is given in Figure 4. The implicit time was the time elapsed from the start of the signal to the P-100 peak. These measurements were made for each subject across all target sizes, colors, and blur levels. Individual measurements were then averaged across all subjects within test conditions. Figure 5 gives a graphical representation of the group averaged VEP data for all viewing conditions. Plate A shows the influence of check size, check color and degree of retinal defocus on the VEP amplitude. Plate B shows the influence of the same parameters on the VEP implicit time.

At the "0" blur level, it is seen that the white/black checks, in general, gave the strongest (amplitude) and fastest (implicit time) signal, across the 3 spatial frequencies examined, followed in order, by the green/black, red/black and blue/black tar-

gets (ANOVA, $p > 0.01$). The vertical separation of the amplitude-blur and implicit time-blur functions for each check color highlights the differential effect of the color content of display stimuli on the afferent component of the neural visual system. Inducing a first level of retinal defocus caused a decrease in the amplitude of the signal measured, more so for the 14 minarc checks (ANOVA, $p = 0.0001$) and for the blue color. The influence of this same amount of blur on the VEP amplitude measured for the 21 and 28 minarc checks was substantially reduced. Increasing the amount of blur to the second and third predetermined levels of blur caused only a small drop in the amplitude of the VEP (Post hoc Student Newman-Keuls test). An increase in the check size from 14 to 28 minarc appeared to minimize the influence of retinal defocus on the strength of the VEP signal (ANOVA $p > 0.09$ except for red). This is seen as a levelling-out of the curves in the graph representing results obtained for the 28 minarc checks.

The influence of retinal defocus on the implicit time of the VEP was especially visible for the blue color (ANOVA $p = 0.0001$ for 14 and 21 minarc), and more so for the 14 minarc check size (ANOVA $p > 0.01$

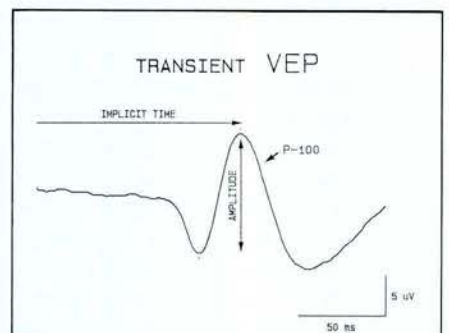


Figure 4

Sample waveform of transient VEP, elicited by visual stimulation with checkerboards reversing at a frequency of 2 Hz. The first major positive peak of the waveform is the P-100 component. The implicit time of the VEP is measured from the beginning of the pattern reversal to the P-100 component. The amplitude of the visual cortical signal is measured as the voltage difference between the trough and the peak of the P-100 component. A scale for the amplitude and implicit time characteristics of the VEP is given at the bottom right hand side of the figure.

except for red) than either 21 or 28 minarc checks (ANOVA, $p > 0.09$ except for blue at 21 minarc and green at 28 minarc). The white, red and green colors did not show as large a delay of their recorded signals under the influence of blur (ANOVA, $p > 0.09$ except for white and green at 14 minarc and green at 28 minarc). It is observed that increasing the check size from 14 to 28 minarc decreased the vulnerability of P-100 to the effects of blur (Post hoc Student Newman-Keuls test). At the largest check size, the influence of retinal defocus on the implicit time was minimal.

Accommodative performance

The laser optometer program used in the present experiment could specify the accommodative measurements as the "accommodative response" or as the "accommodative error". The accommodative response specified the accommodation exerted by the subject for a specific target. The accommodative error identified the dioptric difference between the accommodation exerted by the subject and the accommodative demand as dictated by the viewing distance. Thus, a subject over-accommodated (dioptric value preceded by a "-" sign) if he exerted more accommodation than that required by the target distance and under-accommodated (dioptric value expressed by a "+" sign) if he exerted less accommodation than that required by the test distance. The results shown in the present study have been analysed as the "accommodative error".

Figure 6 presents the group averaged ($n = 20$ subjects) accommodative error as a function of induced optical blur level for each test color across three letter sizes. All the results presented in these graphs, and recorded under blur conditions, have been corrected for the amount of myopia created by the positive spherical lenses used to induce the required levels of blur. The correcting factor for each nearpoint Snellen letter size and blur level was applied to the accommodative responses of each subject and corresponded to the dioptric difference between the positive lenses creating the criterion blur level, and the positive lenses just prior to the ones that created a first perceptible blur of the target. This amount represented the degree of presumed myopia created by the positive lenses and was subtracted from the optometer readout to obtain the "true" physiological accommodation under blur conditions. All the results are referenced to the 632.8 mm red light emitted by the He-Ne laser.

In Figure 6 at the "0" blur level, for the 3 letter sizes examined, a vertical separation

NEURAL PERFORMANCE

MONOCHROMATIC CHECKS AT 40cm ($n = 20$)
(EFFECT OF CHECK COLOR AND BLUR ON VEP AMPLITUDE)

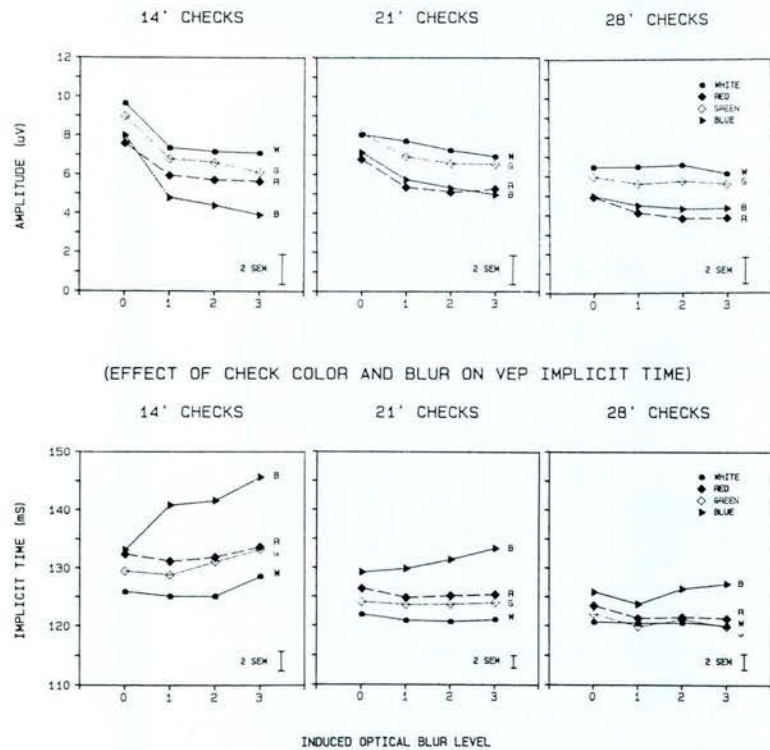


Figure 5

Group-averaged data showing the influence of check color, check size and induced optical blur level on the VEP amplitude (Plate A) and implicit time (Plate B). The vertical bars in the graphs represent 2 SEM values (standard error of the mean). The symbols on the right hand side of each curve identify the colors of the checks used.

OPTICAL PERFORMANCE

MONOCHROMATIC LETTERS AT 40cm ($n = 20$)
(EFFECT OF LETTER COLOR AND BLUR ON ACC'VE ACCURACY)

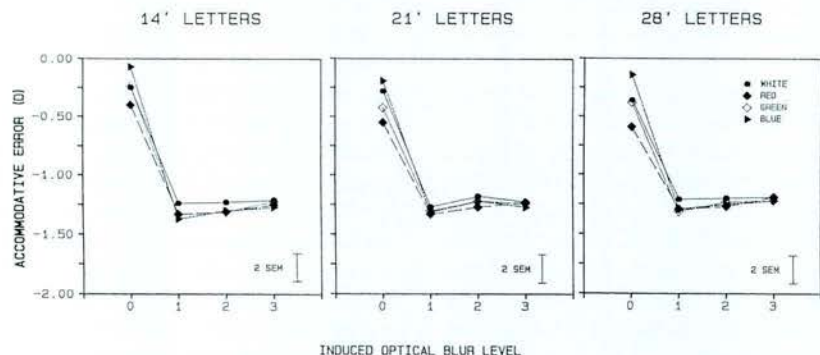


Figure 6

Group-averaged data for the accommodative error as a function of induced optical blur level. The letter size used is identified at top each graph. The vertical bar in each graph represents 2 SEM values (standard error of the mean values). Each color is identified by a specific symbol as illustrated in the left hand side graph.

ration of the accommodative responses for the different colored letters is visible. In general, less accommodation was exerted for a blue than a red target, while the white elicited a level of accommodation about equal to the green color (ANOVA, $p=0.0001$) and Post hoc Student Newman-Keuls test). The size of the letters did not seem to influence the level of accommodation exerted across colors. This is seen in the graphs as nearly identical levels of accommodation exerted for the same color across all 3 letter sizes (ANOVA, $p>0.05$, except for the red and green letters at the zero blur level for the 14 minarc size). A first level of retinal defocus appeared to drive accommodation towards a more myopic level, for all colors and sizes of letters examined. A further increase in the amount of defocus did not have a further effect on the level of presumed over-accommodation. The differential amount of accommodation observed between colors at the "0" blur level was seen to decrease considerably with blur.

Vergence of light as a stimulus for accommodation

The assumed over-accommodation under blur conditions was surprising and would have profound implications for users of VDUs. It was seen that a low level of blur (6/6 blur-out of Snellen letters) apparently drove accommodation towards a myopic

A high precision of accommodation would appear to be required to avoid significant blur resulting from an accommodative reaction to mild defocus.

focus. This implied that the visual fatigue reported by VDU users may have its etiology in relatively small degrees of retinal defocus. Furthermore, a high precision of accommodation would appear to be required to avoid significant blur resulting from an accommodative reaction to mild defocus. In order to clarify the nature of the accommodative response in blur, all 20 subjects were re-examined for their ability to respond to vergence of light as a stimulus for an increase or decrease in accommodation. At this point, we suspected that the accommodative response to the lenses used to create the three levels of blur did not match the nominal dioptric value of the test lens.

ACCOMMODATIVE RESPONSE vs ACCOMMODATIVE STIMULUS (21' WHITE LETTERS AT 40cm n=20)

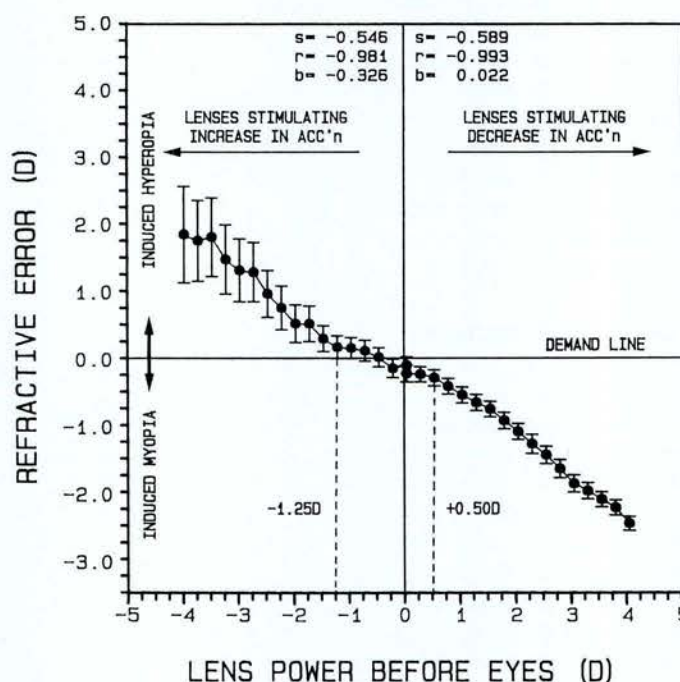


Figure 7

Refractive error as a function of lens power before the eyes for group-averaged data points for 20 subjects. The inset identifies "s" as the slope, "r" as the coefficient of correlation and "b" as the Y intercept for a linear regression analysis of individual data points for the minus and plus lens data sets. Data points illustrate the effect of increasing or decreasing the stimulus to accommodation on the accommodative error. A decreasing number of subjects were able to maintain single binocular vision for minus lens values greater than about 2.50D. The vertical dashed lines limit an interval where the accommodative response was within $\pm 0.25D$ of the demand line. Further increase in the power of the lenses placed before the eyes caused an almost linear increase of the refraction towards myopia or hyperopia.

In the subsequent validation study, the laser optometer was used to measure accommodative responses while the subject binocularly fixated 3 lines of prose on the monitor, containing white/black letters subtending 21 minarc at the ocular plane, at a 40cm observation distance. The screen surface was illuminated by a tungsten light source that provided an illumination of 54 lux. Positive spherical lenses were placed before the eyes, and increased in 0.25D steps from 0.00 to +4.00D. Accommodative responses were recorded for each set of lenses for a 1 minute period. The same procedure was repeated with negative spherical lenses (0.00 to -4.00D in 0.25D steps). Figure 7 presents the group averaged ($n=20$) results of this experiment. The standard error bars through each data point

clearly illustrate a significant inter-subject variability in the accommodative response (and consequent effect on binocularity) to the vergence of light as a stimulus to accommodation, particularly for minus lens powers exceeding -1.75D. The vertical dashed lines delimit a zone where the accommodative error was within $\pm 0.25D$ of the demand line. This shows that the 20 subjects, as a group, were able to relax or increase their accommodation accurately for lenses between +0.50D and -1.25D. A further increase in the power of the lenses before the eyes caused an almost linear increase towards more myopia for plus lenses or hyperopia for minus lenses.

Figure 8 presents a graph of the refractive error as a function of induced optical blur level. Data points in this graph repre-

sent accommodative responses for white/black letters subtending 21 minarc at the ocular plane, for a 40cm observation distance. Curve A shows data points derived from the optometer readout in the baseline study, without any correction factor for the amount of blur induced by the positive spherical lenses. Curve B shows the same data points as in curve A, but adjusted to account for the presumed myopia created by the positive spherical lenses; end points were each subject's report of perceived blur. Curve C shows the true physiological accommodation under no blur and blur conditions, after correcting data points, for the discrepancy between the lens causing the first level of perceived blur and the actual refractive error of the eye for the target distance.

Discussion

The main objectives of the present investigation were 1) to analyse the responsivity of the focussing system of the human eye to display parameters varying in size, color, and degree of retinal defocus and 2) to determine the feasibility of using VEP and laser optometer recording techniques to evaluate these parameters in order to subsequently take advantage of these methods to investigate the role of the accommodative system in the visual fatigue experienced by VDU users. The need for such an examination of the accommodative performance for VDU displayed alphanumeric has been emphasized in a recent technical report by Litton Systems Canada Ltd (1984).²³

The main objectives of the present investigation were

- 1) to analyse the responsivity of the focussing system of the human eye to display parameters varying in size, color, and degree of retinal defocus and 2) to determine the feasibility of using VEP and laser optometer recording techniques

Results of both VEP and laser optometer measurements of neural and optical performance showed considerable inter-subject variability. Nevertheless, the *pattern* of responses across stimuli varying in color, size, and degree of retinal defocus was

highly consistent across subjects. The consistency in these results across test conditions suggests that they are likely applicable to a larger population.

VEP measures clearly identified differential neural responses to VDU stimuli varying in their chromatic content but presented at a common viewing distance. White/black stimuli elicited the strongest signal, followed by green/black, red/black

and blue/black colors. This color ordering in relation to the strength of the neural responses may reflect an improvement of afferent visual signals for stimuli with specific chromatic contrasts. All colors were brightness-matched to blue, leaving an important role to color-contrast in the processing of contour information. Another tentative explanation for the trends in neural responses resides in the fact that brightness-

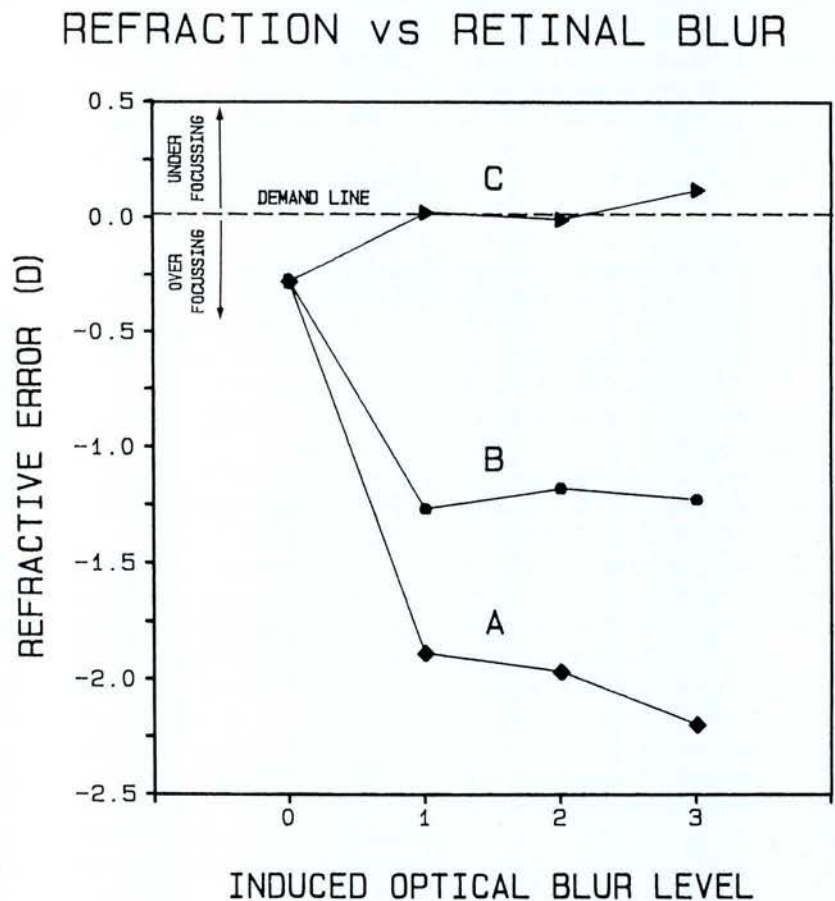


Figure 8

Group-averaged ($n = 20$) refractive error as a function of induced optical blur level, for 21 minarc white/black letters presented on a high resolution monitor at a 40cm observation distance. Curve A represents the accommodative measures as given by the optometer readout, without any correction for the amount of blur created by positive lenses. Curve B represents the same data as in Curve A, but corrected to take into account the presumed induced myopia created by the positive lenses. Curve C represents the same data as Curve A, but corrected for the real amount of induced myopia (by the positive lenses) as derived from the relationship shown in Figure 7 for each subject. The true correction factor was derived by taking into account the discrepancy between the lens power at which the subject first reported the blur and the actual state of ocular refraction. Until the subject reported the first perceptible blur, it was assumed that accommodation was relaxing with increasing plus power. In fact, there was a progressive defocusing of significant dioptric value with increasing lens power before the subject reported a blur.

matched colors did not provide targets of equal luminance. Inasmuch as VEP amplitudes are also related to target luminance, the decreasing amplitudes seen across colors may have been a function of decreasing luminance across the test colors: white (97 cd/m²), green (71 cd/m²), red (34 cd/m²) and blue (17 cd/m²). Finally, the neural responses may have been influenced in part by the effect of the chromatic aberration of the eye²⁴ on the level of accommodation exerted to bring the test colors into sharp retinal focus. Several studies have shown that the wavelength in focus on the retina varies as a function of the observation distance of the target in the emmetropic eye. For distant objects, the red wavelengths are in focus on the retina, whereas the wavelength in focus changes for green at intermediate distances, and for blue at closer distances. This process allows a "sparing" of the accommodative effort as the viewing object approaches the ocular plane²⁵. Furthermore, Sivak and Bobier²⁶ have shown that this mechanism may be a learned one. Our results showed that the white and green stimuli yielded the highest neural responses. This may reflect a more accurate and/or stable focus for these colors at the intermediate distance tested, while the red may have elicited more fluctuations in the accommodative responses. In turn, the blue may have been overfocused thereby decreasing the sharpness of the retinal image. Future experimentation examining the influence of other observation distances, target color, and luminance, may identify display elements that cause accommodative errors which can be correlated with decreased operator performance and visual discomfort.

Laser optometer measures of steady-state accommodation demonstrated a differential accommodative level across targets varying in chromaticity.

Retinal defocus caused a decrease in the amplitude of the VEP and prolonged the neural processing of visual information as judged by the implicit time of the VEP. This was most evident for the 14 minarc checks and for the blue/black targets. The VEP amplitude for this particular stimulus size was decreased mainly at the first level of blur. This is explainable by the fact that a myopia of about 1.50D was induced to achieve the first level of criterion blur,

while, on average, only an additional 0.37D was required to achieve the remaining blur levels. Interestingly, it is seen that increasing the check size from 14 to 28 minarc almost eliminates the effect of blur on the VEP amplitude and implicit time. This is observed in the graphs by a levelling-out of the color curves for the 28 minarc checks. This suggests that for the target sizes examined in this study, chromatic stimuli can be closely matched for presumed optimization of the neural processing of color contrast by using a target size corresponding to 28 minarc. Optimizing the neural responses for chromatic targets presented on VDUs may help in reducing the frequent visual distress associated with their use. Failure to achieve improvement of performance in VDU users with these stimuli may reflect either insensitive measures of performance, or the fact that VEP amplitude and implicit time differences demonstrated here have little significance by the time perception and motoric responses take place. However, clinical reports of functional improvement following remediation of visual problems detected by VEP measurements^{27,28,29} suggest the possibility that operator performance will be optimized for chromatic targets equated by VEP measurements.

Laser optometer measures of steady-state accommodation demonstrated a differential accommodative level across targets varying in chromaticity. This is seen in Figure 6 by the vertical separation between data points recorded at the "0" blur level. As expected, more accommodation was required at the 40cm distance to focus a red target than a blue one, because of the chromatic aberration present in the optics of the human eye. The dioptric difference between the accommodation exerted for a blue and a red target, however, appeared low when compared to previous literature reports for the same 450 to 626nm interval^{30,31} (peak emissions for our blue and red). This discrepancy can be reconciled by the fact that colors on the monitor used in the present study have broadband spectral characteristics. Therefore, to focus chromatic targets presented on a VDU screen, a subject may utilize the longer wavelengths of the broadband blue and the shorter wavelengths of the red, in order to minimize constant readjustments in focussing between colors. If one can adopt such an accommodative strategy, the accommodative strain in visual fatigue associated with VDU usage may be reduced. On the other hand, the dioptric difference across colors examined may be too small to cause visual asthenopia and decreased performance.

The fact that accommodation did not change measurably across the letter sizes examined (14, 21, 28 minarc) suggests that border contrast of letters or perceived distance of targets were more important cues in driving accommodation. Furthermore,

Our results clearly indicated, and confirmed other reports^{32,33}, that chromatic targets displayed on VDU can act as good stimuli to accommodation.

our results clearly indicated, and confirmed other reports^{32,33}, that chromatic targets displayed on VDU can act as good stimuli to accommodation. Therefore, in the design of alphanumeric displays, the primary concern should be the amount of information required, ensuring good legibility without overcrowding the screen, rather than the size of individual elements per se.

The over-focussing responses found under blur conditions initially suggested that a small defocus of alphanumeric on a VDU screen, would drive accommodation into a myopic response. The results presented in Figure 7 provide an explanation for the apparent over-accommodation in blur. These graphs show that a large discrepancy exists between the perception of blur as experienced by the subjects, and the real level of refractive error measured by the laser optometer for the same targets. Hence, while positive spherical lenses were expected to relax accommodation, since the targets were clear to the subject, they were in fact creating a myopic refraction for the target. When a correction is applied for this factor to the optometer readout, it is seen that accommodation remained relatively constant under blur conditions, possibly driven by the perceived distance of the target. This suggests that under blur conditions up to a 6/9 (20/30) blur-out level, accommodation is still accurate for the chromatic target. This result is in agreement with recent work by Ward and Charman³⁴ who found that 2.00D fogging lenses can be applied in front of the eyes before accommodation goes back to its tonic position of rest.

The results of the present experiment clearly indicate that VEP and laser optometer techniques are sensitive methods capable of disclosing small differences across VDU targets varying in size, color, and retinal defocus. The neural study identified target sizes and colors that were more susceptible to the effect of blur. It also indi-

cated an improvement of the VEP signal when target sizes are increased to a level minimizing the blur effect on neural processing. The optical study identified chromatic targets presented on VDU as good stimuli to accommodation, even under conditions of defocused retinal imagery. Small differences were found between the level of accommodation exerted across chromatic letters, presumably due to the broadband characteristics of chromatic display colors. The next and logical step to the present study is to investigate, with the same validated techniques, the effect of prolonged VDU work on the focussing system of the eye, on the possible related visual fatigue, and on the user's performance.

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Experimentally Induced Myopia in Chicks

R.L. Seltner *
J.G. Sivak **

Introduction

Myopia, a condition in which the image falls short of the retina, has been, and continues to be a major human visual concern. After decades of limited and controversial experimental attention, a number of recent studies have demonstrated the possibility of inducing myopia in a variety of animals. The rapid growth and development of the chick make it an ideal model for this type of study. Experimentally induced myopia in chicks provides a laboratory based model for the study of normal and abnormal post-hatching development of the refractive properties of the eye.

After decades of limited and controversial experimental attention, a number of recent studies have demonstrated the possibility of inducing myopia in a variety of animals.

It has been found (Wallman and Turkel, 1978, Hodas *et al.*, 1984, Pickett-Seltner *et al.*, 1987) that myopia can be induced in post-hatching chicks by early application of a goggle designed to eliminate form vision. The myopia observed is characterized by an increase in eye size, both axially and equatorially, large negative refractive error ($-10D$) and an increase in wet weight of the eye (Pickett-Seltner *et al.*, 1987). Although experimental myopia in chicks has been investigated in some detail, further clarification is needed. The temporal pattern of development of the eye size change has not been investigated in detail. The role of the lens in the large refractive error observed needs to be more clearly established. The nature of the size change in the globe needs to be defined. Once these parameters have been more clearly established, the role of other ocular refractive components such as the vitreous humour can be investigated. The investigations undertaken in our lab were designed to clarify the pattern and characteristics of the development of experimentally induced myopia in chicks in the first 2 weeks after hatching.

Materials and Methods

Maintenance of Chicks

The chicks (*Gallus gallus domesticus*) were obtained from a local hatchery on the day of hatching, housed in stainless steel brooders, and fed chick starter and water *ad libitum*. The temperature was maintained at 32°C for the first week and 28°C for the second

week using a red light heat lamp that was thermostatically controlled. The circadian light regime was 14 h light/10 h dark under fluorescent light.

Induction and Measurement of Myopia

On the day of hatching, a translucent goggle was attached with cyanoacrylic glue over one eye of each chick. The goggle consisted of a molded plastic laminate cup with a diameter of 22 mm and a depth of 7 mm. The contralateral eye served as a control.

Refractive state was measured with a Welch-Allyn spot retinoscope and trial lenses. The chicks were refracted to the nearest 0.5 D in the horizontal meridian only. A working distance of 0.5 m was used in all cases. The chicks were assumed to be fixating the environment beyond the experimenter. Fixation and therefore accommodative uncertainty was estimated to be approximately equal in size (one diopter) to measurement error.

After the period of goggle treatment, both eyes of all chicks were refracted. The birds were sacrificed by CO₂ asphyxiation.

Anatomical Measurement

Method 1: Chick heads were frozen in a mixture of acetone and dry ice and sectioned on a freezing microtome. Sections were made along the line of the bill to eye axis. As sections were removed, the block was photographed. The photograph indicating the greatest eye diameter was chosen to represent a sagittal section of the eye. In this way relative internal dimensions of the treated (goggled) and untreated (not goggled) eyes were determined. Axial and equatorial diameters, axial and equatorial lens diameters and anterior chamber depth were measured from the photographs.

Method 2: Measurements of the whole eyes were taken to assess external ocular dimensions, eye weight and lens weight of non-myopic and myopic eyes. Eyes were enucleated by cutting the origins of the extraocular muscles and the optic nerve. Extraneous muscle tissue was removed. Axial measurements were made from the apex of the cornea to the posterior pole of the eye. Equatorial measurements were made along a horizontal plane parallel to the plane of the pupil. Wet eye weight was determined with a Mettler HB pan balance.

Vitreous Volume

Vitreous volume was assessed after removal of the gel and liquid components from the eye. The cornea was pierced and the aqueous drained off. The top of the eye was cut at the level of the scleral ossicles. The cornea was lifted off. The gel vitreous is attached to the lens and surrounding iris and could be separated from these tissues by gentle scraping with a blunt probe. The liquid was removed from the remaining shell and measured in a modified 1 cc syringe.

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Protein Analysis

The lens, sclera, sclera ossicles and cornea were separated from the other ocular components. The sclera/cornea and the lens were extracted separately in 2.0 N NaOH for 7 days. The extract was precipitated with cold 5% TCA. Protein concentrations were determined using a commercially prepared Lowry assay kit (Sigma).

Optical Characteristics of the Lens

The optical properties of an excised lens can be determined by projecting a fine laser beam through the lens at different positions and determining the focal characteristics across the lens. The optical quality of lenses was assessed using an automated device, the scanning lens monitor (Sivak *et al.*, 1986).

Results

Ocular Changes After 14 Days of Unilateral Goggle Wear

Freeze section measurements ($n = 10$) indicate that there was a statistically significant increase in axial and equatorial diameter in the goggle treated eye after 14 days (Table 1). The difference in eye size is accompanied by a large negative refractive error in the treated eye. There was no change in anterior chamber depth or lens diameter in the goggle treated eye when compared to the untreated eye. Whole eye measurements made after 14 days of unilateral goggle wear ($n = 35$) confirm the findings in the frozen sections (Table 1). The treated eyes were larger both axially and equatorially, and had a significantly higher wet weight than the untreated eyes. By contrast, there was no significant difference in mean lens weight between the myopic and non myopic eye. Figure 1 shows the appearance of the freeze sectioned head and the whole chick eyes after 14 days of unilateral goggle wear.

Temporal Study: Induced Myopia and Recovery

Sixty chicks had goggles applied on the first day post-hatching. Thereafter at intervals goggles were removed from 5 chicks and the eyes were assessed for refractive error, wet weight and axial and equatorial diameter. At day 14 the goggles were removed from the remaining chicks, and the eyes of chicks again assessed after various time intervals. The temporal study shows that there is a rapid appearance of differences in all parameters (axial and equatorial diameter, wet eye weight, refractive error) after application of the goggle. The changes are evident in all parameters within 4 days. There is also reversal of these changes within 14 days after removal of the goggle. The physical parameters of the eye had returned to control level by day 28. Experimental myopia in chicks appears rapidly after post-hatching application of a goggle to blur the visual image, and is reversible at least within the first 4 weeks of hatching.

Protein Analysis in the Myopic and Non-Myopic Sclera/Cornea and Lens

The eyes from 10 chicks were examined after 14 days of unilateral goggle wear. The eyes were weighed and measured to confirm the effectiveness of the goggle in the induction of myopia. The goggle treated eyes had a significant negative refractive error (-10.7 ± 3.1 (sd) D) and had increased in wet weight, axial and equatorial length when compared to the contralateral control eye. Lowry assay results on the extracted sclera/cornea and lens are reported in Table 2. There was no significant increase in total soluble protein content in either the lens or the sclera/cornea in the goggle treated eye when compared to the untreated eye.

TABLE 1
A comparison of the ocular effects of
goggle wear for 14 days

Parameter	Myopic Eye		Non Myopic Eye	
	$\bar{x}$	sd	$\bar{x}$	sd
Refractive Error	-11.3	0.3	0	0*
Axial length (mm) ¹	9.7	0.6	8.9	0.5*
Equatorial length (mm) ¹	13.7	0.4	13.0	0.5*
Lens axial length (mm) ¹	2.2	0.2	2.2	0.3
equatorial length (mm) ¹	4.5	0.3	4.4	0.2
Anterior chamber depth ¹	1.4	0.3	1.4	0.3
Wet eye weight (g) ²	1.07	0.11	0.985	0.11*
Axial length (mm) ²	10.5	0.82	8.76	0.54*
Equatorial length (mm) ²	13.3	0.65	12.35	0.51*
Lens weight (g) ²	0.03	0.0	0.03	0

¹Frozen section ($n = 10$)

²Whole Eye ($n = 35$)

*Values are mean $\pm$ standard deviation

*difference between myopic — non myopic significant at the 5% level tested using a modified student t test

TABLE 2
Mean total soluble protein content of the lens
and globe of myopic and non-myopic eyes of chicks
after 14 days

Treatment/tissue	Mean protein (ug)
myopic — sclera/cornea	2296 ($\pm$ 178)
non-myopic sclera/cornea	2272 ($\pm$ 199)
myopic lens	3616 ($\pm$ 202)
non-myopic lens	3509 ($\pm$ 279)

Standard deviation in brackets

Optical Characteristics of the Lens

Lenses from a group of 13 chicks were assessed after 14 days of unilateral goggle wear. Spot retinoscopy showed a mean refractive error of -11.7 ± 0.6 D in the goggle treated eyes. Scans generated by the scanning lens monitor show negative spherical aberration in all lenses, consistent with previous findings for birds (Sivak and Kreuser, 1983). The average relative focal length at the various beam positions was similar in the 2 groups of lenses. Both showed increasing light transmittance towards the optical centre. The results indicate that the optical properties of the lenses were the same in the myopic and non-myopic eyes.

The results indicate that the optical properties of the lenses were the same in the myopic and non-myopic eyes.

Vitreous

In order to investigate the changes occurring in the volume and distribution of the gel and liquid vitreous in experimentally induced myopia, 60 chicks had goggles applied on the first day post-hatching. Thereafter at intervals 5 chicks were assessed for gel and liquid

Figure 1
Appearance of the eye in experimentally induced myopia

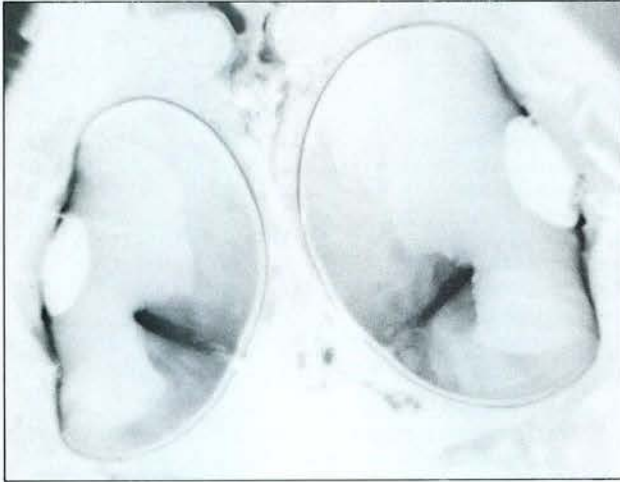


Figure 1A

Frozen section of chick head after 14 days of goggle wear OD – goggle treated eye OS – control eye.

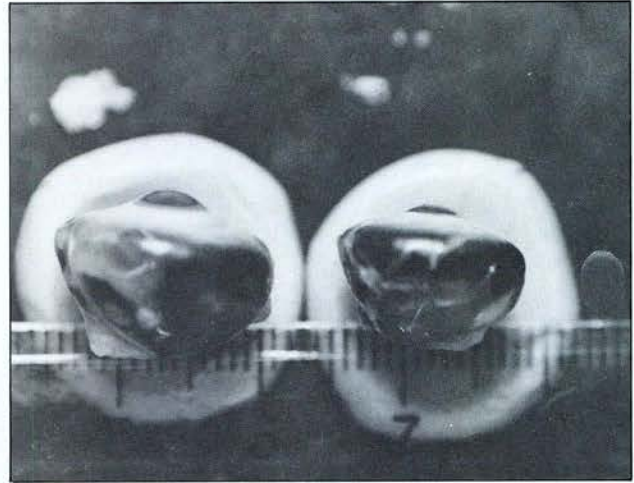
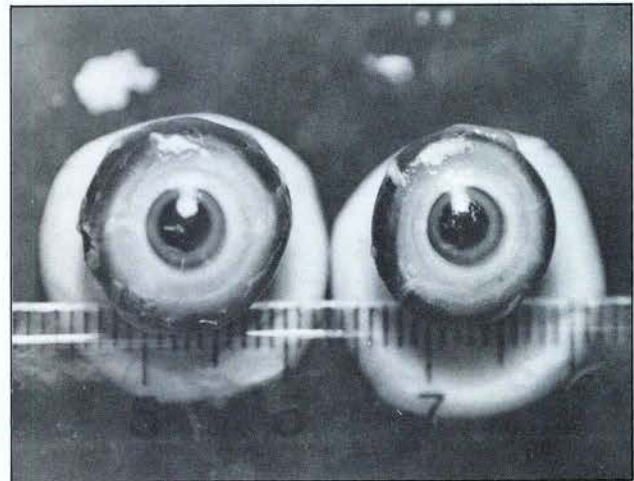


Figure 1B, 1C

Whole eye after 14 days of goggle wear. The eye on the left is the goggle treated eye. The eye on the right is the control eye.



vitreous volume in the myopic and non-myopic eye. At day 14 the goggle was removed from the remaining chicks and assessment was continued at intervals for a further 14 days. It is observed in both the myopic and the non-myopic eye, that the total volume of the gel and liquid increases with the increase in eye size over the 14 day period of goggle wear. The liquid portion increases at a faster rate than the gel in both eyes, consistent with previous observations in the bird eye (Balazs, 1965). However, the total volume of the liquid in the myopic eye was larger, as was the percentage liquid vitreous at day 14. It appears that there is a *de novo* synthesis of liquid vitreous in both eyes. However, this production is increased in the eye subjected to vision blur. The effect also appears to be reversible after removal of the goggle although the ratio of liquid to gel is still higher in the myopic eye at 28 days.

Discussion

The optical properties of the eye are determined by the size and shape of the globe, the curvature of the cornea and the optical

properties and position of the lens. A change in any one of these components may alter the refractive state of the eye. Experimentally induced myopia in chicks provides a laboratory based model for the study of the development of the refractive properties of the eye.

Experimentally induced myopia in chicks provides a laboratory based model for the study of the development of the refractive properties of the eye.

The current studies confirm previous findings (Wallman and Turkel, 1978 Yinon *et al.*, 1979, Hodas *et al.*, 1984) that immediate post-hatching alteration of the retinal image leads to a change in the growth pattern of the eye. This change is characterized by large negative refractive error, increase in both the axial and equatorial

eye diameters, and an increase in the wet weight of the goggle treated eye when compared to the untreated control eye. The results of our temporal study indicate that the changes in eye size which are occurring appear rapidly after the post-hatching application of the goggle, becoming evident in as little as 4 days.

The rapid changes in the refractive properties of the eye after post-hatching goggle application suggest that at the time of hatching development of the chick eye is incomplete, and that there is normally vision dependent post-hatching development of the refractive properties of the eye. The reversibility of these effects after 2 weeks of goggle wear suggests that the changes are dynamic and can be altered throughout the period of rapid development of the chick in the first 6 weeks after hatching.

The eye size increase observed may be the result of an increase in some or all of the cellular components of the globe as a consequence of de novo macromolecular synthesis and cellular proliferation. Alternatively, the observed size increase may be the result of expansion of the existing tissue in the globe without an increase in cell proliferation compared to the non-myopic eye.

The induction of experimental myopia appears to have no effect on the physical, total protein or optical properties of the lens.

The protein assays reveal no significant change in the soluble protein content in the cornea, sclera or scleral ossicles. Therefore, the observed increase in size of the myopic eye does not appear to occur as a result of cellular proliferation of one or more of the tissues of the outer coat of the eye. Moreover, the data suggest that changes may result from expansion of existing corneal and scleral tissue. The wet weight was significantly higher in the treated eye when compared to the untreated eye. The higher wet weight suggests an increase in the fluid accumulation in the myopic eye.

The induction of experimental myopia appears to have no effect on the physical, total protein or optical properties of the lens. It appears that the lens does not contribute to the overall large refractive error observed, and appears to be relatively resistant to changes in the visual environment. This refers only to the fact that the lenses of the 2 eyes, treated and untreated, are equal in size and focal properties, and therefore equal in refractive contribution.

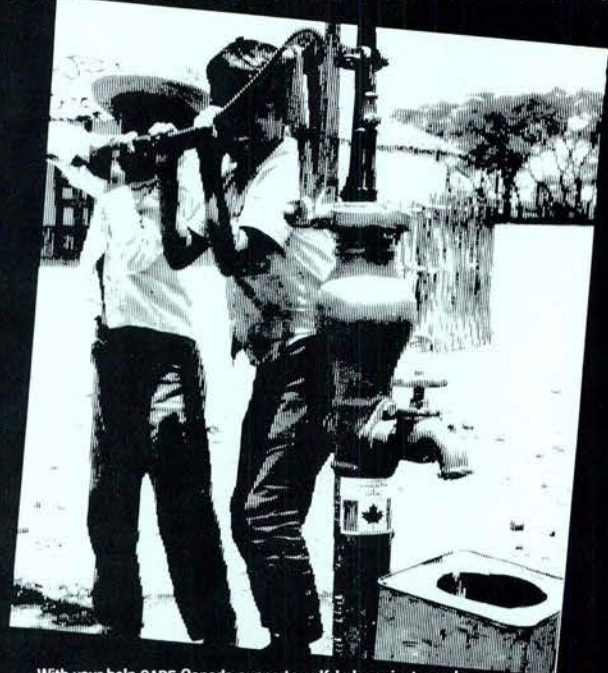
The current evidence suggests a role for the vitreous humour in the development of experimentally induced myopia in chicks. In chicks, the vitreous humour is made up of 2 parts, a gel and a liquid portion (Balazs *et al.*, 1965). The gel consists of a random network of water insoluble collagen fibrils and hyaluronic acid. The liquid vitreous has been shown to be identical to the liquified gel vitreous. In birds during post-hatching development, the increase in the gel volume does not keep pace with the increase in the capacity of the eyeball. At hatching the gel occupies 80% of the vitreous space. By the time the chick has fully developed, the liquid may occupy 60% of the vitreous space. It appears that as the globe size increases, the increased capacity is occupied by liquid vitreous.

Our results indicate that there is an increase in the liquid component of the vitreous in the myopic eye when compared to the non-myopic eye. The source of this vitreous production remains unclear. De novo vitreal production could occur as a result of the blurred retinal image through a local retinal control mechanism. As well, there could be a change in the liquid to gel equilibrium that normally exists in the bird eye. The observed expansion of the globe probably results from the increased vitreous volume within the eye.

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Prevalence of Convergence Insufficiency among Elementary School Children

J.E. Letourneau *
S. Ducic **

Abstract

In order to determine the prevalence of convergence insufficiency among children aged 5-13, a survey was carried out in six primary schools in Montreal with a total of 2,048 students of both sexes. The overall prevalence was 2.25% (CI_{95%}=1.6-2.9) which is less than found in most other studies. Previous prevalence estimates and the possible reasons for this discrepancy, the clinical significance of convergence insufficiency and the diagnostic methods are discussed.

Résumé

La prévalence de l'insuffisance de convergence chez des enfants de 5 à 13 ans a été mesurée dans six écoles primaires de la région de Montréal, soit un échantillon de 2,048 sujets des deux sexes. Le taux de prévalence était de 2.25% (CI_{95%}=1.6-2.9) ce qui est inférieur aux résultats antérieurs. Les raisons de cette différence, la signification clinique de l'insuffisance de convergence et les méthodes de diagnostic sont analysées.

Research on the prevalence of visual disorders among school children has yielded a variety of reports and the majority of school health programs are concerned with the measure of visual acuity. The prevalence of convergence insufficiency is a subject of controversy. Convergence for near vision is an important aspect of comfortable vision. Convergence seems to have been one of the last attributes of binocular vision to have evolved and it also appears to be one of the first to break down and cause symptoms under stress.¹ Convergence insufficiency (CI) is an inability to converge the

eyes to the average or normal near point of convergence (NPC). Convergence insufficiency appears with high exophoria in near vision in association with a rela-

Convergence seems to have been one of the last attributes of binocular vision to have evolved and it also appears to be one of the first to break down and cause symptoms under stress.¹

tively orthophoric condition in distance vision.² A condition of absolute CI may be said to exist when the NPC (in the

absence of presbyopia) is greater than 11 cm from the inter-ocular base line (9.5 cm from the apex of the cornea) or when there is difficulty in attaining 30° of convergence.³

In some cases, CI leads to the appearance of symptoms. Patients may be asymptomatic if they suppress vision from one eye at near or when they do not frequently work at near for long periods of time or in cases where they have a higher threshold for pain and discomfort.⁴ The most frequent symptom of CI is eyestrain after near work.^{3,5-8} Symptoms include diplopia and blurred vision,^{3,4,8-10} headaches,^{3,8} ophthalmodynia^{6,8,10} and tears.⁹ Hirsch¹¹ observed that 38% of these patients complained of ocular fatigue while 25% had headaches and 18% manifested aching, burning or tearing of the eyes. Kent and Steeve¹² came to the conclusion that 60% of CI patients complained of headaches, 49% had blur, 34% showed ocular fatigue and 21% experienced intermittent diplopia. Pickwell and Hampshire¹³ found that 35% of these patients manifested blurred near vision, 10% had blurred distance vision, 9% experienced headaches, 5% complained of tired eyes and 3% showed visual or ocular discomfort. Daum¹⁴ observed that 54% of these patients complained of headaches, 47% had blur and diplopia, 36% manifested asthenopia, 19% showed fatigue, 10% had reading problems and 3% experienced photophobia. Patients may also have difficulties in following moving objects; carsickness also appears when CI is associated with phoria.³

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Prevalence

Data on the prevalence of CI range from 1.75% to 83%^{15,16}. Prevalence is sometimes considered to be low among children under the age of 10^{5,8,15,17}. Results vary with definitions, methods of measurement, sampling, criteria and sex of the subjects.

Three studies at least have been conducted on subjects chosen among normal primary school children. Grieve and Archibald¹⁸ measured voluntary convergence of normal school children (N=104) and found that 44% had no voluntary convergence. Allen *et al*¹⁹ found that approximately 5% of a school population (N=2,000) between kindergarten and 6th grade, had a reduced NPC. Letourneau *et al*²⁰ found that 8.3% of a sample (N=735) of normal primary school children showed CI.

Prevalence of CI has also been studied among children seen in a clinical setting. Smith²¹ found that 73% of otherwise normal children seen in a clinic (N=45) showed signs of CI. Grieve and Archibald¹⁸ measured 86 "problem" children of varying levels of intelligence and emotional stability and found that 60% had no full voluntary convergence at 8 cm.

Three studies at least dealt with dyslexics. A 7-year study was made by Benton²² in an attempt to evaluate the role of binocular control abnormalities in 1500 children of normal IQ but with specific reading problems. Convergence was measured as the ability to converge on a fixation target that approached to 5 cm from the base of the nose, held for a count of 5. Test results showed convergence insufficiency in 22% of dyslexics and 4% of good readers. Norn, Rindziunski and Skydsgaard²³ investigated 117 word-blind children and a comparable control group of 117 normal children; they found a NPC greater than 8 cm in six word-blind and 10 control children. Dunlop¹⁶ tested two groups of selected children aged 7½–11½ years; one group (N=15) had specific learning difficulty while the control group (N=15) consisted of normal readers of the same age and level of intelligence. Convergence was tested to note the effort required to hold full convergence plus voluntary convergence. Four of the normal and 13 of the reading-deficient children demonstrated convergence deficiency, the difference between the two groups being significant ($p < 0.005$). Lieberman²⁴ found that 23% of a population (N=47) of emotionally disturbed children showed CI.

Many studies include both children and

adults. White and Brown²⁵ found that 2.8% of their subjects (N=11,600) showed CI; they may have evaluated a clinical sample. Mann²⁶ analyzed 6,400 cases in her private ophthalmological practice and found that 2.6% showed a deviation of 6 deg or more (exophoria) on the Maddox

Wing and an inability of voluntary convergence (without a fixation object). There was no significant correlation with age or refractive error; voluntary convergence seemed to be acquired normally at about the age of 6. Kratka and Kratka⁵ found that 25% of patients seen in a clinic

TABLE 1
Prevalence of Convergence Insufficiency among Children and Adults

	N	Children < 14 years %	Children and adults %	Tests and distance
Allen & al ¹⁹	2 000	5		
Benton ²²	1 500	22 c		PC- 5 cm
Benton ²²		4		PC- 5 cm
Dunlop ¹⁶	15	83 c		VC-
Grieve &	104	44		VC- 8 cm
Archibald ¹⁸	86	60 b,d		VC- 8 cm
Kratka & Kratka ⁵	500		25 a	PC, Maddox Rod, vergence/divergence
Letourneau & al ²⁰	735	8.3		PC- 10 cm
Lieberman ²⁴	47	23 d		PC- 10 cm
Mann ²⁶	6 400		2.6 a	VC
Norn ¹⁵	10 022		1.75 a	PC- 9 cm
Norn & al ²³	117	5 c		PC- 8 cm
Pickwell & Stephens ²⁷	200		37 a	PC & JP- 10 cm
Pickwell &	505		22 a	JC- ?
Hampshire ¹³	505		12 a	PC- ?
Smith ²¹	45	73 a		?
White & Brown ²⁵	11 600		2.8*	PC- 20 cm

a) Clinical sample
b) Mentally retarded children
c) Dyslexics
d) Emotionally disturbed
*) Undetermined

PC: Pursuit Convergence
JC: Jump Convergence
VC: Voluntary Convergence

TABLE 2
Prevalence of CI by age and sex

Age	Boys			Girls			Total		
	CI	N	%	CI	N	%	CI	N	%
5	1	36	2.8	1	20	5.0	2	56	3.6
6	2	111	1.8	2	124	1.4	4	235	1.7
7	2	156	1.4	3	117	2.6	5	272	1.8
8	2	160	1.25	3	165	1.8	5	325	1.5
9	4	171	2.35	4	183	2.2	8	354	2.2
10	3	142	2.11	4	122	3.3	7	264	2.6
11	3	115	2.6	3	122	2.5	6	237	2.5
12	2	88	2.3	4	88	4.5	6	176	3.4
13	0	23	—	1	12	8.3	1	35	2.85
Total	19	1001	1.9	25	953	2.1	44	1959	2.25

(N=500) showed CI; 75% of these cases complained of symptoms. They measured the NPC, the phorias at 6 m and 33 cm, and also convergence/divergence at 6 m and 33 cm. Norn¹⁵ found that 1.75% of 10,022 patients showed CI when pursuit convergence was measured at 9 cm. Pickwell and Stephens²⁷ observed that 37% of patients (8 to 83 years) seen in a private practice (N=200) showed signs of CI when pursuit and jump convergence were measured at 10 cm. Pickwell and Hampshire¹³ also found that 22% of patients examined in a private practice (N=505) showed inadequate convergence when measured with a jump-convergence and a pursuit convergence test; when the NPC was measured, 12% of these patients had a NPC over 10 cm.

More females than males
show CI in a ratio of 3:2.

More females than males show CI in a ratio of 3:2.^{4, 10, 15, 28} Manson²⁹ postulated that this difference could be related to anemia secondary to gynecological or menstrual problems.

Methods

Subjects

Previous studies^{15, 19, 20, 22, 23, 25, 26} on samples taken from populations of children had shown a probable prevalence of 5%. The size of the sample was calculated using 5% as expected CI prevalence and precision was held at 1% with 95% confidence. Out of 17 elementary schools with a total of 9,844 students aged 6-13, six schools were selected and their total populations examined (N=2,048). This number is in excess of a sample size of 1,825 required to determine, with 95% confidence and within 1%, the true prevalence of CI. Only schools in one reasonably typical middle income area of Montreal were selected. Subjects were predominantly French-speaking with some English-speaking of Italian descent and French-speaking children of Haitian origin.

Apparatus

The target was a diode at the top of a 30 cm vertical bar. The bar was on a track 120 cm long. The target could be moved up to 8 cm from the eyebrows of the subject who was sitting facing the track, his head on a headrest. The target was moved by a motor at the speed of 35 cm/s. Five

switches of different voltage were on or off in succession at distances of 19.5 cm on the track so that it was always possible to determine the position of the target on the track.

Eye movements were measured by Electrooculography (EOG). Four electrodes (Beckman 265 — 083527-5) were placed on the internal and external canthi of each eye of the subjects. Eye movements were amplified with a Grass amplifier (#7P122B) and recorded on a Hewlett Packard Tape Recorder. It was then possible to record at the same time the position of the target and eye movements within a margin of error of 100 msec. The operator looked for NPC. The NPC was measured by determining the closest point to the subject along the primary sagittal line at which he could still continue to fixate the target with both eyes. This distance from the spectacle plane or the bridge of the nose was defined by the objective observation of the deviation of one eye. Recorded data were printed on paper and analyzed subsequently.

The reliability of the test was measured before the experiment on a group of 15 CI patients. The measure of the reliability of the test was a necessary but not a sufficient condition for its validity. If the results of the test had not been reliable i.e., unstable over a period of time, it

would have been useless to try to assess its validity. Results of these subjects did not vary over two weeks when NPC ($t=1.72$ $df=17$) was measured.

Procedure

A screening was conducted to detect cases of CI. The NPC was measured with a penlight which was approached slowly to the bridge of the nose while subjects maintained a foveal image in both eyes until the limit of binocular convergence was found. The NPC was measured objectively at the point in space where the eyes ceased to converge. When the distance exceeded 10 cm on three trials the case was regarded as one of CI. This criterion of CI is the same as defined by most of the authors who measured the ability to converge^{15, 20, 23, 24, 27}. Subjects who showed a NPC greater than 10 cm were submitted to a cover test and 3.31% were rejected because a tropia existed. A total of 171 children who showed normal binocular vision were kept after screening.

These subjects were submitted to the test sitting in front of the track. The electrodes were placed on the two canthi of both eyes and on ear lobes after jelly had been put on the electrodes. The apparatus was calibrated while subjects kept their head on the headrest. Calibration was necessary so that a zero value was ob-

TABLE 3
Characteristics of the subjects eliminated from the sample
on account of other anomalies of binocular vision

	Boys	Girls	%
Strabismic subjects	35	36	3.31%
Subjects without binocular vision	2	5	0.33%
Uncooperative subjects	6	3	0.42%
Anisometropic subjects	2	3	0.23%
Paralysis of external rectus muscle	1	0	0.05%
Nystagmic subjects	1	0	0.05%

TABLE 4
Proportions of convergence insufficiency and
excluded subjects by school

	N ₀	Excl.	%	N ₁	CI	%
School A	548	29	5.3	519	12	2.3
School B	501	18	3.6	483	10	2.1
School C	394	15	3.8	379	8	2.1
School D	127	12	9.4	115	4	3.5
School E	297	16	5.3	281	6	2.1
School F	181	4	2.2	177	4	2.25
Total	2048	94	4.6	1954	44	2.25

tained on the oscilloscope when subjects were fixating the target at 2 meters in the midline position and to avoid saturation on the tape recorder.

Results and discussion

Forty four children (2.2%) showed signs of CI. They had an exophoria which was greater for near than for distance ($t=7.49$, $p<.001$) and a NPC greater than 10 cm. This figure is lower than that obtained by many authors for many reasons. The sample is drawn from a general population and not from a clinical setting, subjects showing anomalies of binocular vision have been excluded, pursuit convergence was measured instead of voluntary convergence or jump convergence, and the measure was objective (EOG). Moreover, the norm (10 cm) was conservative, the size of the sample was adequate, the subjects were less than 13 years old and they had to converge on the target for a period of only 5 seconds.

Although the clinical importance of CI has been recognized from the time of von Graefe's, the prevalence is still discussed and the mechanism is unclear more than a century later.

These results can be compared with those obtained by Mann²⁶ (2.6%), Norn¹⁵ (1.75%) and also White and Brown²⁵ (2.8%). These data must be regarded as a conservative figure. All the subjects who were kept after screening ($N=171$) would have been considered cases of CI (8.3%) if a penlight had been used; this figure could be compared with another study in which the same method and the same criterion had been used.²⁰ Clinical sample^{5, 13, 15, 21, 26, 27} should be analyzed with caution when prevalence is evaluated since they could be biased. Measures of voluntary convergence^{16, 18} have little clinical value. The sample should also be adequate and the number of subjects evaluated by the formula:

$$N = \frac{z^2 \pi (1-\pi)}{\epsilon^2}$$

where z determines the level of confidence α , π is the probable prevalence in the population and ϵ is the precision of the estimate; few authors have used this formula or an equivalent to determine the number of subjects which should have been included in their sample. Finally, the

speed of the target could change the results and include cases of "slow convergence". Although the clinical importance of CI has been recognized from the time of von Graefe's, the prevalence is still discussed and the mechanism is unclear more than a century later.

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Aniseikonia and Unequal Vertex Distances: A Case Report

R.F. Krebs *
K.M. Robertson **

Abstract

A 23 year old female had complained of intolerable headaches and eyestrain experienced after only short periods of spectacle wear. Using measurements obtained on a newly designed eikonometer¹, a small degree of aniseikonia through her spectacles was detected. Complete correction of aniseikonia was achieved by equalizing the vertex distances in front of both eyes. This was accompanied by complete cessation of her symptoms and allowed prolonged and comfortable spectacle wear.

Résumé

Une femme de 23 ans se plaignait de migraines intolérables et de fatigue oculaire même en n'ayant porté ses lunettes que peu de temps. Les relevés pris à l'aide d'un eikonomètre, d'invention récente, a permis de déceler une anisèikonie légère avec les lunettes. On a pu corriger entièrement l'anisèikonie en égalisant les distances axiales en face des yeux, ce qui a totalement éliminé les symptômes et permis le port prolongé et sans problème des lunettes.

Patient CI is a 23 year old female part-time student who also works as a medical underwriter. She presented herself at the School of Optometry Clinic at the University of Waterloo wanting to be fit with contact lenses. Case history at this and subsequent visits revealed that headaches and eyestrain were symptoms commonly

experienced by the patient when reading, working at the VDT, or even simply looking in the distance as when driving. They were felt most severely when she was doing work at near, and were known to develop sometimes after only 15 minutes of spectacle wear. However, when the patient did not wear her glasses (was either uncorrected or wearing current pair of contact lenses), she experienced no such symptoms. Although her current contact lenses were fitting uncomfortably, she preferred them over her glasses.

Findings from a complete visual assessment and further contact lens visits were unremarkable. Her refractive error, -1.25 DS O.D.; -1.50 DS O.S., was accurately corrected with her current spectacles. Visual acuities through her spectacles and new contact lenses were measured at 6/4.5 O.D.; O.S.; O.U. Further testing at the Binocular Vision Clinic detected only slightly decreased accommodative facility. Spectacle parameters such as base curves, PD and thicknesses at optical centres were also verified and showed a difference in lens thicknesses, the left lens being thicker. An aniseikonia assessment on the Multimeridional Apparent Frontoparallel Plane¹, a recently developed sensitive eikonometer, revealed the presence of 1% magnification in the right eye relative to the left eye. With a 1% magnifier over the left eye, the aniseikonia was completely corrected. Similarly, no aniseikonia was evident when assessment was done without the spectacles.

With this information it was apparent that a difference in image size was being created by the patient's spectacles, and it seemed likely that although small in magnitude, this may be the cause of her symptoms. It was noted that the spectacle frames were not adjusted correctly, the left lens vertex distance to be greater than that of the right. Calculations of the minification due to the spectacles with the two different vertex distances showed a difference of 1%. The necessary adjustments were made so that the vertex

distances were now equal for both eyes. Another measurement on the eikonometer followed and revealed no aniseikonia.

The patient was then asked to wear her spectacles (now properly adjusted) for a period of two weeks and report back to the Clinic. At that time, and even a month thereafter, the patient reported complete absence of symptoms and was able to wear her spectacles without difficulty.

Discussion

Aniseikonia, even of small magnitude, can for some patients be the cause of rather severe symptoms. This example emphasizes the reality of aniseikonia resulting from unequal spectacle vertex distances, and serves

This example emphasizes the reality of aniseikonia resulting from unequal spectacle vertex distances, and serves as a reminder of the importance of proper spectacle adjustments.

as a reminder of the importance of proper spectacle adjustments. Furthermore, it cautiously reminds us that it is oftentimes easy to overlook the "minor" causes in search of the "major" ones.

Acknowledgement

We would like to thank Dr. A. Remole for the use of his new Eikonometer for measuring aniseikonia.

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BOOK REVIEWS/LU POUR VOUS

Practical Aspects of Ophthalmics, 3rd Edition by Margaret Dowaliby, O.D. 1988, Professional Press Books, Fairchild Publications, 7 East 12th Street New York, NY, 10003. 202 pp. text, 6 pp. bibliography, 6 pp. General Index, 131 line illustrations. \$33.00 (\$US)

This text fills a present day void created by an overemphasis on contact lenses, pathology and an accompanying tendency among clinicians to abandon the dispensing aspects of practice.

Although many texts on dispensing and practical optics have appeared since the classic *Modern Ophthalmic Lenses* in 1939, they have been directed to mechanical, rather than to prescribing aspects. It is still a truism that, in order to meet the visual needs of a patient, the practitioner must be fully aware of what devices are available and the characteristics of each one.

This book provides not only the necessary practical knowledge but also contains valuable clinical pointers for selecting and making the best use of lenses. Much more than a mere list of different types and makes of lenses, *Practical Aspects* . . . also discusses the basics of geometrical and physical optics related to lenses, lens materials, safety factors, tints and their purposes, coatings on glass and plastic, absorptive lenses, base curves, induced vertical prisms and the effect of lens tilt on prescriptions. Chapters on lenses, bifocal construction, base curves and induced prisms are enhanced by sample problems to facilitate explanations.

There are 15 chapters in all, the longest of which discusses characteristics of lenses, a title less frightening than "Geometrical Optics of Lenses". Five chapters are assigned to bifocals, trifocals, double

segment lenses and progressives. Some 20 pages are devoted to plastic materials, their advantages and available single vision and multi-focal lens types. The two chapters on absorptive and safety lenses contain several gems of wisdom to answer the neverending questions patients ask.

No text would be complete without some reference to base curves and aniseikonia, induced prism and power changes due to lens tilt. In *Practical Aspects* . . . , these aspects are briefly but adequately presented.

A last chapter counsels on frame materials, frame selection and the need for frame shapes to conform to the design characteristics of multifocal lenses. As an example, aviation shapes, small PD's and progressives do not mix well.

This book should be a prescribed text in all Optometry schools in the fond hope that students will not forsake our optical heritage and will learn to take pride in prescribing the best appliances or devices possible for every patient. Even currently active practitioners could do much worse than to invest in this book and relearn to apply its principles.

Perhaps if clinicians were to use a greater variety of designs, there would be less danger of good designs' being withdrawn from the market from lack of use, an event occurring with far greater frequency in the face of the growing presence of international firms in the ophthalmics industry, the Directors of which all too often seem unable to understand other than their profit and loss computer read-outs.

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Dr. Barb Caffery, Toronto, on "Latest Developments in the Field of Contact Lenses".

Dr. A.L. Maberley, M.D. (ophthalmologist associated with Vancouver General Hospital), on "Retina".



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Dr. Joel Zaba, Norfolk Virginia, on "Children, Children, Children".
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New From Allergan / Daily Cleaners and Comfort Drops

Allergan Optical recently announced the introduction of several new products: New Hydrocare and Oxysept Daily Cleaners, both in 30 mL size and new "gentle formula" Oxysept and Hydrocare Comfort Drops, in 15 mL size, designed to complement their existing Hydrocare and Oxysept starter kit systems.

Further information is available from local Allergan representatives.

New Instrument From Down Under Overturns Eye Image

An Australian invention is being promoted by its developer as a device to enable eye doctors "to diagnose eye problems earlier".

The binocular magnifying ophthalmoscope, invented by Perth Lions Eye Institute's Max Cuyper, an optics research officer, is said to offer a greater magnification (15 times) and wider field of view than that presently available with other equipment.

In addition, the new ophthalmoscope gives an upright, rather than an inverted image of the eye and offers a video camera mount to enable filming of the examination. In the accompanying photo, inventor Cuyper is shown holding the instrument with video camera attached. The instrument has received patents in both the US and Australia.

Further information (Quote Australian Overseas Information Service/Research and Health Bulletin P88/20 (23/8/88/2):



Australian High Commission
50 O'Connor Street
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American Academy of Optometry to Meet in Columbus, Ohio

Symposia on lasers, fundus imaging, UV radiation and contact lens advances will highlight the 1988 Annual Meeting of the American Academy of Optometry slated for December 8 - 12 at the Ohio Centre Hyatt Hotel in Columbus, Ohio.

The total schedule of education programming planned for this year's meeting offers attendees a substantial choice and includes the two-day Ellerbrock CE Program (190 hours); three days of papers (36 hours); posters (10.5 hours); Section symposia (63 hours) and awards lectures and presentations (three hours). Complementing the education program is a scheduled 12 hours of access to the Exhibit Hall.

Meeting registration material has already been mailed to Academy members in both the US and Canada and may also be obtained from the organization itself at the following address: American Academy of Optometry, 5530 Wisconsin Avenue NW, Suite 1149, Washington, DC, 20815, USA. Tel. (301) 652-0905.

Acuvue® Launches National Disposable Contact Lens Campaign

Johnson and Johnson has formally kicked off its national Canadian marketing campaign around the much-publicized Acuvue® Disposable Contact Lens.

The lens, manufactured by Vistakon, a Johnson and Johnson company, was first introduced in Canada last April in BC, following its North American debut in Florida last year. In Canada, it is distributed exclusively by Plastic Contact Lens Company (Canada) Ltd.

The Acuvue is available in powers ranging from -0.50 to -6.00D, in 0.25D increments. It has a base curve of 8.80mm, diameter of 14.0mm and its centre thickness ranges from 0.11 to 0.06mm, depending on power. Practitioners are offered two dispensing options: either the lenses are mailed

VISION CARE NEWS/ACTUALITÉ OCULO-VISUELLE

to the doctor's office, or are mailed directly to the patient's home on either a three or a six months' supply at a time basis.

In its August, 1988 news release package, Hill and Knowlton (Canada) Limited, the PR counsel for Johnson and Johnson on this particular campaign, also advises that Toronto optometrist Dr. Brian Levy has been appointed as a member of the Canadian Acuvue Advisory Panel and is "a professional who has been using the new lenses in his practice".

The package received by the CJO * RCO included a four-page news release and three glossy photos introducing the product, a brief corporate profile of Vistakon, answers to thirteen "frequently asked questions" about the Acuvue Lens, a biography of Dr. Levy, two articles reprinted from *Contact Lens Forum* entitled "The Economic Impact of Disposable Lenses", by Drs. R.P. Snyder, J. Solomon and P. Klein, all O.D.'s and "Health Aspects of Contact Lenses", by Dr. P. Asbell, M.D.



Copies of the kit are available from:

Hill and Knowlton (Canada) Limited
International Public Relations Counsel
160 Bloor Street East
Toronto, ON
Tel. (416) 926-7400

And, for more detailed information about the lens itself:

Dr. Sam Nisenboim
Plastic Contact Lens (Canada) Ltd.
Tel. (416) 865-4070

Coming Events

(Note: For further information on an event sponsored by the Canadian Association of Optometrists, contact the CAO office in Ottawa. For an event sponsored by a provincial Association or Society of Optometrists, contact the respective hosting organization. The address for an international or outside Canada event is included with the item.)

1988

DECEMBER / DECEMBRE

8 - 12 American Academy of Optometry

1988 Annual Meeting
Ohio Centre Hyatt Hotel
Columbus, Ohio

Information:

American Academy of
Optometry
5530 Wisconsin Avenue SW
Suite 1149
Washington, DC
20815, USA
Tel. (301) 652-0905

1989

FEBRUARY / FEVRIER

13 - 15 Optical Society of America Topical Meeting

"Noninvasive Assessment of the Visual System"
Eldorado Hotel
Santa Fe, New Mexico

Information:

Optical Society of America
Visual System
1816 Jefferson Place NW
Washington, DC
20036, USA

MARCH / MARS

24 - 30 Seventh Asian Pacific Optometric Congress

Malaysia
Part 1: March 24, 25 at the
Shangri-la Hotel
(Kuala Lumpur)

Part 2: March 26 - 30 at the
Tanjung Aru Beach
Hotel (Kota Kinabalu,
Sabah, North Borneo)

Information:

IFAPAO Secretary-General
Dr. Damien P. Smith
7 Cookson Street
Camberwell 3124, Victoria
Australia
Tel. (03) 882-9122

JUNE / JUIN

22 - 25 Optics Asia '89 International Exhibition

(Singapore Optical Trade
Association)
World Trade Centre, Singapore

Information:

ITP Services (Private) Limited
994 Bendemeer Road
No. 04 - 03
Singapore 1233
Attn. Jimmy Bong
Director and Project Manager

AUGUST / AOÛT

1 - 4 Canadian Association of Optometrists Association Canadienne des Optométristes

RENDEZ-VOUS OTTAWA '89
21st Biennial Congress /
21^e Congrès Biennal
Ottawa, Ontario

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Our family of rigid gas permeable lens materials and solutions are perfected through clinical observations of in-eye performance to provide wearers with the very best in comfort, visual acuity and corneal health.

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With Torissoft®,
their eye shape doesn't have to
shape their eyewear.



Your astigmatic patients may not have to wear glasses if they don't want to. Torissoft® toric lenses have a patented "thin zone" design.

Your astigmatic patients will love their feel. Comfortable. You'll love their fit. Stable. And how they build your practice. Up.

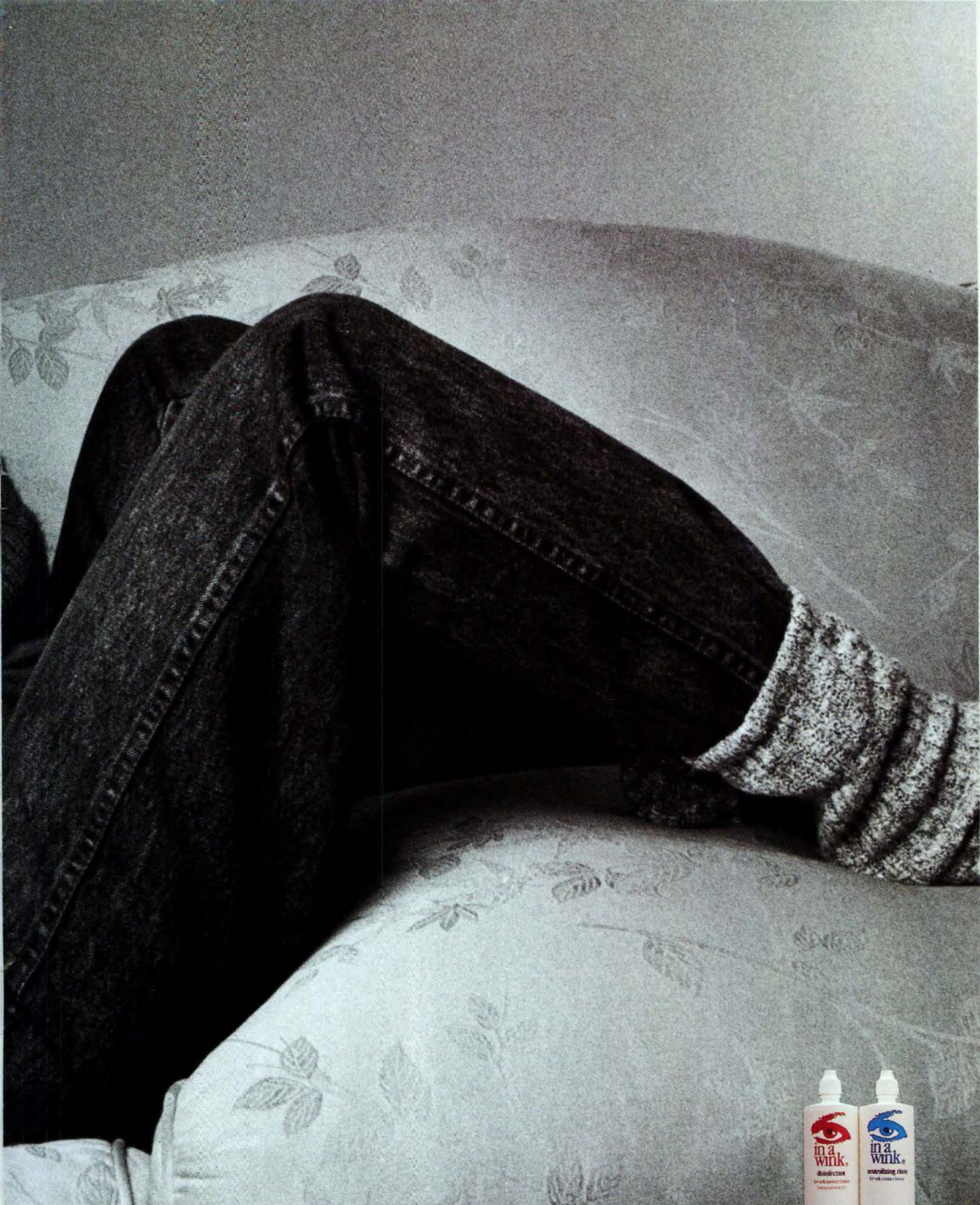
TORISOFT®

The leading edge in comfort.

CIBAVision



How many hours do you think she can spare for lens care?



With In a Wink, all she needs is 25 minutes. Because that's all it takes to disinfect and neutralize soft contacts once they've been cleaned. For lens care when there's no time to spare.



**In A Wink
Fast & Flexible
CIBAVision.**

ATTENTION!

In Ottawa — Canada's Capital Region — we like to make every convention a ceremonial occasion.

And that's what you and your colleagues can look forward to as you plan for the *21st Biennial Congress of the Canadian Association of Optometrists*, "Rendez-vous Ottawa '89", August 1-4.

We'll get your attention with our many famous national attractions like the Governor General's Footguards and Parliament. You can explore the new National Gallery of Canada, National Aviation Museum and Canadian Museum of Civilization. And you can take in a command performance at the National Arts Centre, hike the Gatineau Hills or stroll along the Rideau Canal.

And of course, as a visitor to the Capital, you'll have *our* complete attention, too!

See you in Ottawa in '89!

Why not plan a vacation in Ottawa — Canada's Capital Region before or after the 21st Biennial Congress? We'd be happy to send you more information. Just write or call.

Canada's Capital Visitors and Convention Bureau
222 Queen Street, 7th Floor
Ottawa K1P 5V9
(613) 237-5150

ATTENTION!

À Ottawa — la région de la capitale du Canada — nous traitons chaque congrès comme une occasion solennelle.

Et c'est ce à quoi vous et vos collègues pouvez vous attendre en planifiant le *21^e Congrès biennal de l'Association canadienne des optométristes*, "Rendez-vous Ottawa '89", qui aura lieu du 1^{er} au 4 août.

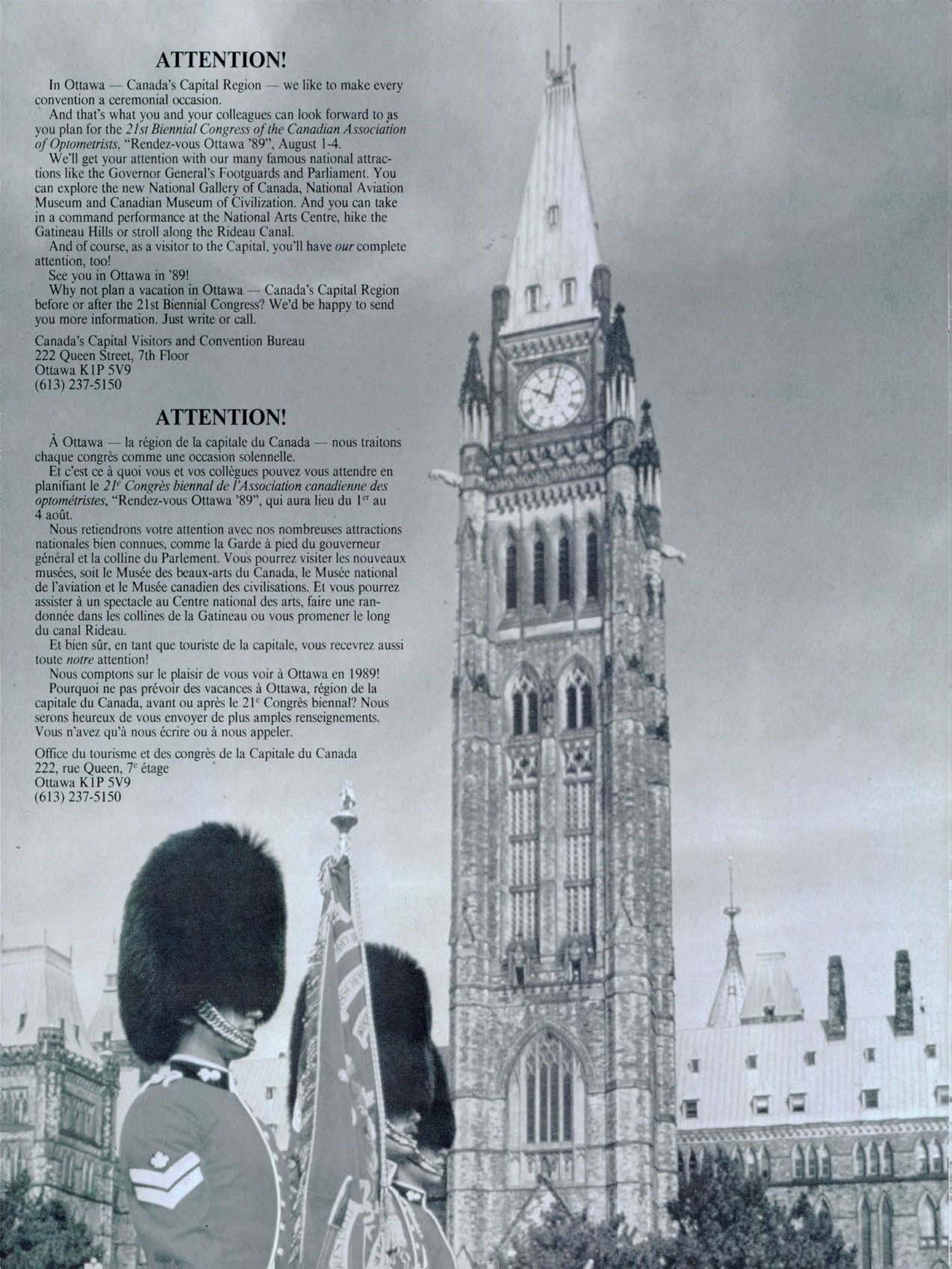
Nous retiendrons votre attention avec nos nombreuses attractions nationales bien connues, comme la Garde à pied du gouverneur général et la colline du Parlement. Vous pourrez visiter les nouveaux musées, soit le Musée des beaux-arts du Canada, le Musée national de l'aviation et le Musée canadien des civilisations. Et vous pourrez assister à un spectacle au Centre national des arts, faire une randonnée dans les collines de la Gatineau ou vous promener le long du canal Rideau.

Et bien sûr, en tant que touriste de la capitale, vous recevrez aussi toute *notre* attention!

Nous comptons sur le plaisir de vous voir à Ottawa en 1989!

Pourquoi ne pas prévoir des vacances à Ottawa, région de la capitale du Canada, avant ou après le 21^e Congrès biennal? Nous serons heureux de vous envoyer de plus amples renseignements. Vous n'avez qu'à nous écrire ou à nous appeler.

Office du tourisme et des congrès de la Capitale du Canada
222, rue Queen, 7^e étage
Ottawa K1P 5V9
(613) 237-5150



You're looking at the reason for Visitint.



If you could see the clear contact lens
on this page, you see better than the vast majority of people.
But if all you could see was the tinted, easy-to-find
Visitint lens, you also see the reason why more and more eye
care practitioners are recommending this handling tint.

VISITINT™

The future of contact lenses is no longer clear.

CIBAVision

Introducing ... Number 1 in a Series "An Introduction to Contact Lenses"

**A 10 Minute Video to Educate Potential Contact Lens Patients
Produced by Optometrists for Optometrists**

After a year in production, the B.C. Association of Optometrists is proud to announce the completion of a high quality video: "An Introduction to Contact Lenses", designed to make patients aware of the ever changing world of contact lenses.

Already in use in many B.C. offices, this video allows optometrists to educate potential contact lens patients in a clear, consistent manner about the realities of contact lens wear. It can be utilized either before, during, or after contact lens evaluations, allowing practitioners to more efficiently use their time. Optometrists using the video have commented that patients are more aware of the specific components of contact lens care, have a better grasp of different contact lens designs and materials and thoroughly understand the role of their optometrist in providing contact lens care.

This is an ideal way of educating prospective contact lens patients about the pro's and con's of contact lens wear. Aimed at helping you achieve better patient management, this 10 minute video will save you valuable office time. Produced by the Public Relations Committee of the B.C. Association of Optometrists, it guarantees each individual receives the same high quality message.

All proceeds go to producing a second video for educating patients who choose to wear contact lenses.

HIGHLIGHTS

- * **Clear, consistent message for education of potential contact lens wearers.**
- * **Using the services of an award-winning production house, this video was made by optometrists to stress the role of the optometrist in providing contact lens care*.**
- * **Allows for efficient use of patient/doctor time.**
- * **Cost: \$95.00 with funds going towards future projects – specifically a generic instruction and training video for contact lens patients.**
- * **Copyrighted to protect the profession: thus unauthorized reproduction cheats the profession as a whole.**

**(This is the same video producer we used for "Life is Worth Seeing" which won a prize at the 1988 U.S. Film and Video Festival in Chicago).*

Order Form

Pre-paid orders only. Allow up to 6 - 8 weeks for delivery. Send cheque or money order for **\$95.00*** payable to **B.C. Association of Optometrists**, to:



BCAO Contact Lens Video

125 - 10451 Shellbridge Way
Richmond, British Columbia
Canada V6X 2W8



NAME (Please Print): _____

ADDRESS: _____

TOWN: _____ PROV/STATE: _____

POSTAL/ZIP CODE: _____ COUNTRY: _____

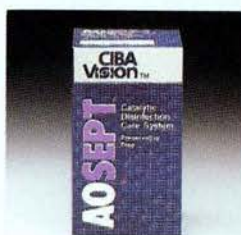
*(*U.S. orders: please pay \$95 U.S. to cover extra shipping and handling).*

We've just made it easier to keep your AOSept patients in line.



We'd like to introduce the AOSept Care System's New Look.

It's a look that eliminates product confusion; with a distinct navy grid and bold colour-coded lettering, there's no mistaking what your patients



The new AOSept System contains: AOSept-, and AODisc-, Softcon® Cleaner, AODrops-, (comfort drops), protein tablets and your choice of CIBA Vision Saline (preserved) or CIBA Vision Saline Spray (preservative-free).

will look for when they replace the components of the AOSept Care System you've given them.

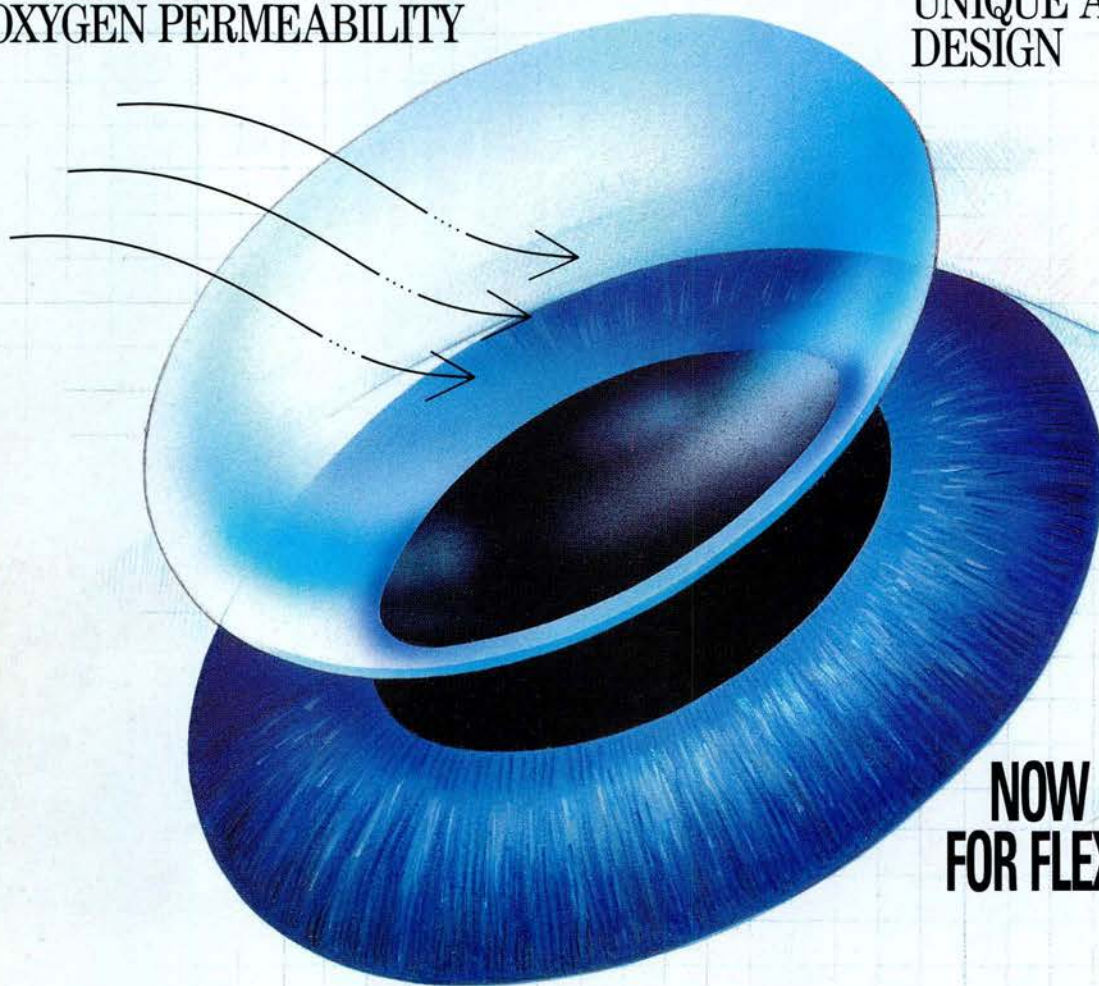
Preservative-free, simple to use and now easy to find. No wonder AOSept is the fastest-growing peroxide system in Canada.

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Now A Major Advance In The Lens/Cornea Relationship.

HIGHEST AVAILABLE
OXYGEN PERMEABILITY

UNIQUE ASPHERIC
DESIGN



NOW SUITABLE
FOR FLEXIBLE WEAR

Better Corneal Health and Comfort Made from a new lens material called sifluocon A, Quantum lenses have the highest oxygen permeability available in an RGP lens (Dk of 92×10^{-11} @ 35°C). This material provides excellent wettability and deposit resistance. Plus, the unique aspheric lens design complements the cornea's natural curvature for a superior fit over spherical lenses.

Excellent Visual Performance The careful blending of a spherical central optic zone into an aspheric peripheral curve is a major achievement in contact lens design. With a spherical central curve, patients receive maximum optical stability and now don't have to sacrifice visual performance to enjoy the superior fit of an aspheric lens.

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ZONE

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OPTIC
ZONE

ASPHERIC
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ZONE

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Preservatives cause irritation.
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At a price they can afford.

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