Perimetry&
Imaging
in Shakespeare's Country

15th Visual Field Symposium
of the International
Perimetric Society (IPS)
Stratford, England
June 26 - 30 2002

Abstract
Book

To have seen
what I have seen,
see what I see!

William Shakespeare
Hamlet Act 3

15th Visual Field Symposium of the International Perimetric Society (IPS)

'Perimetry and Imaging in Shakespeare's Country.'

June 26th – June 30th 2002

WELCOME TO STRATFORD UPON AVON

It gives me great pleasure to welcome you to Stratford upon Avon for the 15th Visual Field Symposium of the International Perimetric Society (IPS) 'Perimetry and Imaging in Shakespeare's Country.' The Meeting takes place in the Stratford Moat House Hotel, which is situated in the heart of Stratford, from June 26th-30th 2002 inclusive.

Stratford upon Avon is a small old Elizabethan town on the gently flowing River Avon and was the birthplace of William Shakespeare in 1564. The charming town centre features 16th and 17th century buildings with rows of half-timbered houses, including Shakespeare's home. Stratford is also well known as a venue for Shakespeare's works, with three popular theatres: The Royal Shakespeare Theatre, The Swan and The Other Place.

An excellent scientific programme is described within this abstract book.

The Society is grateful to all the Sponsors of the Meeting but particularly to the Major Sponsors: Heidelburg Engineering, Interzeag AG, Pharmacia Ophthalmology, Carl Zeiss/Welch Allyn, and. Allergan.

The International Perimetric Society Visual Field Symposia not only feature presentations on the latest scientific findings but also include a strong social element where members and delegates from many countries meet in a fellowship of science and culture. An exciting social programme is planned including the Welcoming Dinner at Ragley Hall, a beautiful 17th Century Palladian home; a visit and dinner at Warwick Castle, a breathtaking monument rising majestically above the banks of the River Avon and which dates to William the Conqueror; and a tour through the Cotswolds to Blenheim Palace, a World Heritage site which is the ancestral home of the Dukes of Marlborough and the birthplace of Sir Winston Churchill. The Meeting climaxes with the traditional IPS Banquet.

I look forward to meeting you all here in Stratford upon Avon and wish you an enjoyable stay.

With best wishes

John Wild PhD

Host

Thursday 27th June

09.00 2nd International Perimetric Society Lecture

I come to praise Perimetry - Erik L Greve, Amsterdam, The Netherlands.

The origin of the IPS: conception, birth, early childhood. Traquair, Goldmann, Dubois-Poulson, Harms & Aulhorn, Fankhauser, Heijl-Patella, Godfathers. The roaring seventies. From kinetic to static to automatic. Differential threshold or else? Wedge shaped field defects. The impact of fast techniques. The art of Perimetry and its artifacts. Glaucomatous visual field loss: is it really so late? Screening for glaucoma. Reversibility or variation. Perimetry in animals. Is that all there is? Perimetry in present day management of glaucoma. I come to praise it. The world is all interpretation. The illusion of vision. Is there a future?

Session One: Statistical Techniques and Variability I

Moderators: Lars Frisen, Göteborg, Sweden; Yoshiaki Kitazawa, Gifu, Japan.

9.30 A new spatial filter for visual field data: Derivation and reducing noise

SK Gardiner[1], DP Crabb[1], FW Fitzke[2], RA Hitchings[3]. Nottingham Trent University, Nottingham, UK[1], Institute of Ophthalmology, London, UK[2], Moorfields Eye Hospital, London, UK[3].

Background: Simple spatial filtering (Gaussian filtering) of visual field data after perimetric examination for glaucoma has been shown to reduce noise in the measurements, but may 'blur' defects and scotomas of interest. **Purpose:** To develop a new spatial filter for reducing noise in visual field data which takes into account the physiological structure of the eye. **Methods:** From a uniquely large retrospective database of 98000 visual fields from patients at a glaucoma clinic, obtained from Humphrey perimetry, the covariances between sensitivities at different points in the eye were obtained. Series of regressions on these covariances were used to produce a map, detailing how to predict the sensitivity of a point from the sensitivities elsewhere in the field. The filtered value at that point is then a combination of this predicted value and the raw sensitivity measured during the test; where the raw value is given more weight at points that were found to be less predictable (based in part on the correlations between the raw and predicted values). This leads to a unique filter for each location in the field. To test the filter, the correlation between sensitivity and time was found for fields 3 through 20 of each sufficiently long series in the database, before and after filtering. **Results:** Details of the map were found to conform to the expected structure of the retinal nerve fibre layer. Filtering significantly increased the correlation between sensitivity and time; the proportion of the series which had a correlation >0.5 doubled with filtering. This indicates that the values are less noisy after filtering, as they are more consistent over time. **Conclusions:** The new filter appears to reduce the noise present in visual field readings.

9.42 A new spatial filter for visual field data: Testing and evaluation

DP Crabb[1], SK Gardiner[1], FW Fitzke[2], RA Hitchings[3]. Nottingham Trent University, Nottingham, UK[1], Institute of Ophthalmology, London, UK[2], Moorfields Eye Hospital, London, UK[3].

Purpose: To demonstrate how a new spatial filter could be used on visual field data to improve diagnosis of visual field progression. **Methods:** First, 5000 noisy visual field series (consisting of 5 years worth of annual tests) were simulated for a stable field. Next, 5000 noisy visual field series (of 5 years) based on each of ten different artificial localised defects (consisting of 1 or more points deteriorating at 2dB/yr, and the 2 points at either end of the defect deteriorating at 1dB/yr) were simulated. The probabilities of each point from each series being flagged as progressing by pointwise linear regression were measured. An unrealistic non-glaucomatous defect, perpendicular to the expected shape, was tested in the same way. **Results:** For a stable field, the proportion of points flagged as progressing (all of which are false positives) was 0.59% for the raw data, improving to 0.04% after filtering. Out of the localised defects tested, the new filter increased the proportion of progressing points successfully detected in all ten cases (on average from 19.6% to 33.3%) whilst the Gaussian filter reduced this proportion in three of the cases (and gave an average of only 22.6%). The proportions of points detected from the unrealistic defect fell after filtering the raw data (from 19.7% to 10.0%) whereas Gaussian filtering increased this proportion to 30.0%. **Conclusions:** The new spatial filter decreases the number of false positives when detecting progression by reducing the level of noise present. The new filter behaves and discriminates quite differently to the Gaussian filter in that it significantly increases the probability of detecting true deteriorating points (even

in localised defects) and it also reduces the chances of flagging unrealistic, non-glaucomatous defects. The filter could provide a useful tool for improving visual field measurements.

9.54   A variance-equalising transformation for the analysis of visual fields

Hong Gu,[1] Paul H Artes,[2] David C Hamilton,[1] Balwantray C Chauhan[2] [1]Departments of Mathematics & Statistics and [2]Ophthalmology, Dalhousie University, Halifax, Canada.

Background: The variability of threshold estimates increases when visual field sensitivity is reduced, but, owing to the limited dynamic range of automated perimetry, decreases again when visual field defects advance towards absolute loss. The strong, non-monotonic relationship between sensitivity and variability makes it difficult a) to estimate trends over time and their significance, and b) to quantify differences in variability between patients with different levels of visual field loss. The purpose of this work was to develop a transformation to equalise the variability of threshold estimates across the scale of conventional perimetry. **Methods:** The relationship between sensitivity and variability was characterised by a gamma-like function in longitudinal visual field data from 108 patients with glaucoma and 113 normal controls. This function, in turn, was used to find the appropriate variance-stabilising transformation for the measurement scale (dB). Test/retest intervals (5th and 95th percentiles of retest threshold estimates, stratified by baseline sensitivity) were subsequently derived on the transformed scale. **Results:** The function fitted to the sensitivity-variability relationship had similar parameters for controls and patients with glaucoma, reaching its maximum at approximately 10 dB. The transformation of the scale by the integral of this function eliminated the relationship between sensitivity and the variability of threshold estimates and lead to nearly uniform test/retest intervals across the entire dynamic range. **Conclusions:** The transformed scale may increase the power of trend- and event-type analyses for the detection of visual field progression.

10.06   A new scoring program for quantification of the visual field

E. Gandolfo, P.Capris, E.Zinzini, A.Franzoni, F Gandolfo and F.Morescalchi University Eye Clinic of Brescia, Brescia, Italy.

Purpose: To develop a computer automated program for functional scoring of the binocular visual field loss. **Methods:** A computerized perimetric test was developed for the quantification of the visual field according to the recent legislation on peripheral visual impairment. This new designed law recognises the disability caused by the visual field constriction and classifies 5 categories: 1) mild low vision: binocular visual field residual (b.v.f.r.)< 60%; 2) moderate low vision: b.v.f.r. < 50%; 3) severe low vision: b.v.f.r. < 30%; 4) partial blindness: b.v.f.r. < 10%; 5) total blindness: b.v.f.r. < 3%. **Results:** The pattern of the program consists of 100 locations, 40 situated in the upper hemifield and 60 in the lower hemifield; 64 catch trials are presented inside the central 30° and 36 in the peripheral 60°. The strategy chosen is age related suprathreshold with quantifying of defects in three zones. At the end of the examination an assessment of the percentage of the residual visual field may be given. **Conclusions:** This binocular test can be easily programmed in all the main perimeters and it may be utilized for legal or insurance purposes. Sensitivity and specificity of the test are discussed.

10.10   Ageing and variability in normal and glaucomatous visual fields

Paul H Artes, Raymond P LeBlanc, Balwantray C Chauhan. Department of Ophthalmology, Dalhousie University, Halifax, Canada

Purpose: To investigate the effects of age on visual fields, and to examine the variability of pointwise sensitivity estimates over time. **Methods:** Visual field data (HFA 30-2 Full Threshold test) were collected, in intervals of 6 months, from one eye of 113 normal controls (age on study entry, 30–76 yrs, median 47.5 yrs) and 108 patients with glaucoma   (15–87 yrs, median 61.5 yrs). Follow-up ranged from 2 to 9 yrs. (median, 7.5 yrs) for the glaucoma group and from 2 to 11 yrs (median, 5.7 yrs.) for the controls. Longitudinal analysis (sensitivity vs. age relative to patient's mean value across follow-up) was compared to cross-sectional analysis (sensitivity vs. age). Variability was quantified by the distribution of residuals from pointwise linear regression, stratified for sensitivity. **Results:**   The longitudinal analyses gave lower estimates of age-related change than the cross-sectional analyses. The rate of sensitivity loss was largest in the upper periphery, and least in the inferior periphery of the field, and accelerated in patients older than 60 yrs. Variability varied strongly with sensitivity, but the differences between glaucoma patients and normal controls were small when the effect of sensitivity was accounted for. **Conclusions:** Ageing may affect the upper and lower parts of the visual field differently. It may not be appropriate to estimate trends in individuals by using slope estimates from cross-sectional analyses.

10.22 A corrected malfixation index for the Heijl-Krakau method

Joerg Weber, Köln, FRG.

Purpose: In the Heijl-Krakau fixation test, a positive answer of the patient following a stimulus located in the blind spot is usually counted as a fixation loss. However, a false positive answering behavior adds to true perceptions of the stimulus due to loss of fixation. Thus, the rate of false answers for the Heijl-Krakau-Method is a combined index and reflects fixation loss only with a bias. **Methods:** The mathematical model for the combined probability of random false positive answers and probability of fixation loss (as measured with the Heijl-Krakau-Method) follows the formula $P(\text{combined}) = P(\text{false positive}) + (1-P(\text{false positive})) * P(\text{fixation loss})$. Based on the model, the probability of fixation loss can be estimated from the measured rate in that way (R=measured Rate): P estimated(fixation loss) = $(R(\text{Heijl-Krakau})-R(\text{false positive})) / (1-R(\text{false positive}))$. This estimate is called "corrected Malfixation index". **Results:** By mathematics, the "corrected Malfixation index" is always smaller than the uncorrected rate of the Heijl-Krakau-Method. Examples of patients with good fixation, but high false positive answer rate show a higher validity of the corrected Malfixation index compared to the uncorrected Index. **Conclusion:** Use the corrected index for clinical evaluation.

Session Two: Imaging I

Moderators: Bal Chauhan, Halifax, Canada; Michele Iester, Genoa, Italy.

11.00 The effect of contour-line drawing criteria on optic disc parameters as measured with the HRT.

FA Ennis, GA Cioffi, SL Mansberger, CA Johnson. Discoveries in Sight, Devers Eye Institute, Portland, Oregon.

Purpose: Numerous studies have examined the reliability and reproducibility of measurements using the Heidelberg Retina Tomograph. However, the effect of criteria used in defining the optic disc margin and placement of the contour-line, has not been thoroughly assessed. This is clinically relevant, as measurements from the HRT that are contour-line dependent are used in the final analysis in discriminating glaucomatous from non-glaucomatous subjects. Therefore, the purpose of this study was to examine the effect of contour-line placement upon HRT measurements. **Methods:** Contour-lines were drawn by an experienced technician on 105 HRT mean topography images of 105 glaucomatous or glaucoma-suspect eyes. Optic disc parameters were then measured via the HRT software. The contour-lines were erased and then later redrawn using a second set of optic disc margin criteria. HRT disc parameters were then re-measured and compared with the previous results. **Results:** Correlations between the two contour-line criteria were statistically significant for 13 of the 14 HRT parameters assessed, although some correlation coefficients were as low as 0.31. The 3rd moment, however, showed no significant correlation (r=0.032, p=0.75) for the two sets of criteria. **Conclusions:** The relatively low correlation coefficients for many of the HRT parameters implies that caution must be exercised in interpreting data if the specific contour-line drawing criteria are not known. Furthermore, diagnostic criteria which use the 3rd moment should not be used on HRT images where the contour-line has been drawn using criteria other than those used in the development of the diagnostic criteria in question.

11.12 Discriminant analysis formulae to detect glaucomatous optic discs

Michele Iester[1], Christian Y. Mardin[2], Wido M. Budde[2], Anselm G. Jünemann[2], Jochen K. Hayler[2], Giovanni Calabria[1] and Jost B. Jonas[2,3] 1) Department of Neurological and Visual Sciences, Ophthalmology, University of Genoa and Division of Ophthalmology of the Gaslini G Institute, Genoa, Italy, 2) Department of Ophthalmalogy and Eye Hospital, Friedrich-Alexander-University Erlangen-Nürnberg, Erlangen, Germany, 3) Department of Ophthalmalogy and Eye Hospital, Faculty of Clinical Medicine Mannheim, University of Heidelberg, Mannheim, Germany.

Purpose: To evaluate whether discriminant analysis formulae of optic disc variables measured by confocal laser scanning tomography can show up glaucomatous visual field defects. **Methods:** One hundred and sixty-one patients with perimetrically defined glaucomatous optic nerve damage and 194 normal subjects were recruited. All patients underwent confocal laser scanning tomography of the optic disc. The data were analyzed by three linear discriminant analysis formulae (sectorial formula, Bathija's formula, Mikelberg's formula). The discriminant formulae had been obtained in sets of data completely different from the data of the present study. **Results:** The areas under the ROC curves of the three formulas and of the Cup Shape Measure as single parameter ranged from 0.649 to 0.81 in the entire group, and the results did not change when age-matched eyes were considered (from 0.618 to 0.812). All three formulas were better than the Cup Shape Measure as single parameter. **Conclusions:** In the various chronic open-angle glaucomas, the sectorial formula and Bathija's formula tended to have higher diagnostic precision than Mikelberg's

formula and the cup shape measure. The scores of the formulas are mild indicators of the amount of glaucomatous visual field loss.

11.24 **Confirmatory results in suspect glaucoma patients with normal visual field and abnormal retinal nerve fiber layer findings.** A Bjerre, DB Henson, AJ Kwartz, S Mahmood, JR Grigg, AF Spencer. School of Medicine, University of Manchester, Manchester, UK.

Purpose: To investigate 36 eyes with normal perimetric findings and abnormal GDx results.
Methods: 36 eyes of 22 patients who on at least 3 consecutive visits, demonstrated normal visual fields (Humphrey Field Analyser 24-2 full threshold) and loss of retinal nerve fiber layer (GDx parameters outside normal limits) were further examined with the Heidelberg Retina Tomograph and multifocal visual evoked potential (objective perimetry). Masked color stereoscopic photographs of the optic nerve head were also classified by three glaucoma specialists. Scores of 0, 1, and 2 were allocated to the classification of normal, borderline, and glaucoma for each test. A total score was calculated for each eye. **Results:** The sample consisted of 13 females and 9 males (mean age 62.3 ± 9.8 years). The distribution of scores is given in the table. A score of 2 indicated that only the GDx showed abnormal results and a score of 8 indicated that all the tests (other than the visual field) were abnormal. The battery of tests confirmed an abnormal/suspicious result in a proportion of the patients but not in others.

Total score	2	3	4	5	6	7	8
Percentage of eyes	14	42	8	19	17	0	0

Conclusions: Disparities in diagnostic tests for glaucoma occur in a proportion of patients, and it is important in these cases not to rely upon a single test outcome but to do a battery of tests before making clinical decisions.

11.28 **Ability of the Heidelberg Retina Tomograph and GDx to detect patients with early glaucoma** AJ Kwartz, DB Henson, AF Spencer, RA Harper, D McLeod. School of Medicine, University of Manchester, UK

Purpose: To investigate the ability of the Heidelberg Retina Tomograph (HRT) and GDx to identify patients with early primary open angle glaucoma. **Methods:** HRT and GDx measurements were taken from 19 patients who had recently developed repeatable perimetric defects (defined by the Glaucoma Hemifield Test); optic nerve head characteristics were not used as inclusion criteria. Imaging data were classified as abnormal if they fell beyond the 95% confidence interval. HRT data took into account optic nerve head size (Moorfields regression analysis) and GDx data considered the 'number', average thickness, ellipse modulation and total polar average. **Results:** The experimental group was aged 64.09±9.44 years with early visual field loss (mean MD -1.48±1.60dB). The sensitivity of the HRT was 74% (95% CI: 54 – 93%). The sensitivity of the 'number' was 53% (95% CI: 30 – 75%). Each of the other 3 GDx parameters had sensitivities of less than 15%. **Conclusions:** The HRT demonstrated better ability than the GDx to detect patients with early glaucomatous field defects. However, 5 patients (26%) were classified as within normal limits by both instruments.

11.40 **Assessment of digital stereoscopic optic disc images using a Z Screen**
JE Morgan, [1]NJL Sheen[2], R Goyal[1], JM Wild[2], RV North[2], 1. Department of Ophthalmology, University of Wales College of Medicine, Cardiff, UK. 2. Department of Optometry and Vision Sciences, Cardiff University; Cardiff, UK.

Purpose: To determine the ability of digital stereoscopic optic disc analysis to identify glaucomatous optic nerve damage in eyes with early visual field loss. **Methods:** Simultaneous (Nidek 3Dx) and sequential (Nikon F505) optic disc images of 56 glaucoma and 60 normal subjects of similar age were obtained. The Diagnosis of glaucoma was established using HODAPP grading of 2 consecutive Humphrey 24-2 SITA-Standard fields. Optic disc appearance and intraocular pressure were not used to make the diagnosis. Both sequential and simultaneous optic disc images were digitised at high resolution and viewed stereoscopically using a Monitor Z screen (Stereographics Corp.). Images were viewed stereoscopically using an interlaced display method. Three observers (residents in training) who were masked to patient diagnosis subjectively graded disc images as normal or glaucomatous. They then outlined optic disc and cup borders using a cursor whose depth, in viewing space could be adjusted to match that of the scleral rim. The scaling factors for each image were determined for the calculation of neuro-retinal rim area (at 30° intervals) and total disc areas using established algorithms. **Results:** The mean visual field defect (MD) for the normal group was -0.38dB, (PSD 1.88) and -4.46 dB for the glaucoma group (PSD 5.28). Best subjective grading gave a sensitivity of 80.3%, specificity 93.3% for the discrimination of

glaucomatous optic discs. When account was then taken of optic disc area by performing linear regression analysis of optic disc area and the log transformed neuroretinal rim area (in 30 degree segments), glaucomatous optic discs could be detected with sensitivity of 82.3%, and specificity of 93.3%. **Conclusions:** Digital stereoscopic viewing systems, in conjunction with simultaneous stereoscopic optic disc photography enable the discrimination of glaucomatous optic neuropathy with clinical useful sensitivity and specificity. Similar levels of diagnostic precision could be achieved when the images were analysed subjectively and quantitatively.

11.52   **The ability of the Heidelberg Retina Tomograph and GDx to predict the development of visual field loss.** AJ Kwartz, DB Henson, AF Spencer, RA Harper, D McLeod. School of Medicine, University of Manchester, UK.

Purpose: To assess the ability of the Heidelberg Retina Tomograph (HRT) and GDx to predict the development of glaucomatous visual field loss. **Methods:** HRT and GDx measurements were taken every 6 months from 284 patients 'at risk' of developing glaucoma. Perimetric results were categorised by the Glaucoma Hemifield Test, with consecutive normal and non-normal results required at baseline and to confirm conversion. HRT analysis took into account disc size. Linear regression analysis was performed on 4 GDx parameters (the 'number', average thickness (AT), ellipse modulation (EM) and total polar average (TPA)), to determine whether significant change (non-zero gradient) had occurred during the study. **Results:** Nineteen patients developed field defects during the study (duration: 2.32 ± 0.71 years) with a mean deviation (subsequent to conversion) of -1.48 ± 1.60dB. At baseline, the HRT categorised 12 patients (63%) as having glaucoma & 7 (37%) as normal (at 95% specificity), with 2 (11%) showing conversion during the study. Three patients (16%) showed significant longitudinal change in the GDx 'number' (p<0.05). AT, EM and TPA changed for 1, 1 and 0 subjects, respectively. The HRT agreed with all cases detected by the GDx. **Conclusions:** The HRT showed better ability than the GDx to predict field loss. Over 60% of patients demonstrated abnormal discs (according to the HRT) at least 2 years before repeatable field defects. However, 5 (26%) had consistently normal discs throughout the study.

11.56   **Sectorial and diffuse optic nerve hypoplasia: diagnostic value of scanning laser polarimetry (GDx), correlated with automated perimetry findings.**
V.Vaclavik, and A.B.Safran. Geneva University Eye Clinic, Geneva, Switzerland.

Introduction: Clinical diagnosis of optic nerve hypoplasia, either sectorial or diffuse in pattern, can be difficult. The anomaly, however, deserves to be recognized, particularly when visual field defects are present. Our observations emphasize the diagnostic interest of quantifying the peripapillary neurofiber layer (NFL) in such cases. **Methods:** The study includes 25 eyes of 13 adults (9 women and 4 men) presenting with papillary hypoplasia. The condition was incidentally discovered during routine fundoscopic ophthalmologic examination. Malformations varied in shape (i.e., with sectorial or diffuse pattern, tilted disc syndromes) and degree. Visual field (VF) was assessed by Octopus threshold automated perimetry. Using GDx scanning laser polarimetry, thickness and distribution of the NLF were evaluated. **Results:** NFL thickness was reduced in cases of papillary hypoplasia (i.e., with an optic disc less than 1.9 mm2 in surface). In this condition, GDx measurements showed a reduced NLF in the concerned area (i.e., a reduced integral of thickness by quadrant). NFL findings and VF defects were correlated. **Conclusions:** This study corroborated the idea that hypoplasic optic nerves as a rule contain a reduced amount of the optic nerve axons. Diffuse or sectorial anomalies often affect the visual field. When GDx values are abnormal, before considering a glaucoma diagnosis, evaluating both the amount and repartition of axons in different sectors of the peripapillary NFL, and carefully assessing surface and morphological pattern of the disc, are mandatory. Correlation between GDx measurements and VF findings was informative.

Session Three: Basic Science I

Moderators: Ron Harwerth, Houston, Texas, USA; Joerg Weber, Cologne, Germany.

12.00   **Normal Relationship Between Luminous Threshold and Critical Flicker Fusion Frequency**
Javier Rodríguez, Mónica García, Marta González-Hernádez, Manuel González de la Rosa University of La Laguna, Canary Islands, Spain.

Purpose: To establish the relation between Differential Luminous Thresholds (DLT) and the Critical Flicker Fusion Frequency (CFFF). **Methods:** 28 eyes from 28 healthy subjects, with previous perimetric experience, mean age 34.7 years (SD=14.1) and refractive error lower than 3 diopters (spherical equivalent) were examined twice using the Octopus 1-2-3 peirmeter; once for measuring CFFF with Flicker perimetry (Background 31.4asb, stimulus Goldmann III at 4000 asb and 1 sec long) and another with conventional DLT perimetry. In both cases, the TOP strategy and grid 32 were used. **Results:** A relation of 1 dB = 1.27±0.03Hz was obtained in the 74 examined points. Our previous estimation (Perimetry Update, 1993) had some local variability, with average deviations of 1.25 Hz from the normal CFFF values, underestimating them in the peripheral areas and mostly on the upper field. The relation is more uniform on the present sample. The deviation of the real local mean value from the estimated mean value is 0.6 Hz. The RMS error value between the CFFF and the estimated from the DTL on the 2072 examined points was 7.9Hz. The CFFF loss with age (0.075Hz/year) was equivalent to the loss for differential luminous thresholds (0.059dB/year), with a ratio between them of 1.27. **Conclusions:** There is a tight functional dependence between DTL and CFFF that, on the Octopus 1-2-3 and for the kind of stimulus used, is 1dB=1.27Hz. This relation between both physiological functions happens to be more constant than what has been estimated so far using different samples of subjects.

12.04   **Detection of M-Cells loss in ocular hypertension and glaucoma**
M Altieri,[1] U Vogt[1], A Morland[2], K Ruddock[2], C Migdal[1] 1 The Western Eye Hospital, London, UK 2 Imperial College, London , UK

Purpose: To detect the M-Cells loss with psychophysical tests studing the temporal response characteristics in Ocular Hypertension subjects and Glaucoma patients. **Methods:** 76 eyes of 76 patients were included in our study. The total group was subdivided according to 1998 European Glaucoma Society guidelines in three subgroups : 24 eyes with Glaucoma, 30 eyes with Ocular Hypertesion (OHT) and 22 Normal-control eyes. Each eye was tested with a stimulation software,developped in Imperial College, who showed that the responses called ST2 have similar characteristics to those found in the magno-cellular pathway . The measurement of temporal responses rest upon the measurement of a target which moves across a background modulated temporally (flicker). Each eye was also tested with the Frequency Doubling Technology perimeter who has the theoretical capacity to test the same retino-cortical pathway. Correlations and clinical agreement between the two psychophysical tests were studied. **Results:** A statistically significant agreement between the two techniques was found (p<0.05). In the OHT group significant changes in the magnocellular response were found. In both OHT and Glaucoma the temporal processing showed greatest abormalities at a small number of low flicker frequencies. Significant correlations were found between the ST2 responses and the FDT indices (MD and PSD). **Conclusions:** The studied psychophysical tests are usefull in screening for glaucomatous damage specially for the provided evidence of the detectable M-ganglion cell damage in patients with OHT who remain normal on testing with standard threshold perimetry.

12.08   **Spatial summation for a single line and multi-line motion stimulus.** GM Verdon-Roe,[1] DF Garway-Heath,[1,2] MC Westcott,[2] AC Viswanathan,[1] FW Fitzke[2] The Institute of Ophthalmology[1] & Moorfields Eye Hospital, London[2]

Purpose: To investigate spatial summation for motion displacement of line stimuli as a function of line length, line number and line separation. **Methods:** A video display under PC control was used to present horizontal line stimuli of either a single line or triple lines separated by 8, 14, 27 or 54 min arc. Two experienced normal subjects were tested at -27,3 eccentricity with peripheral refraction corrected. Five presentations of each of 7 motion displacements were made between 0-24 min arc. Stimulus presentations consisted of 3

SUMMATION EFFECT OF EQUIVALENT SINGLE AND TRIPLE LINES
Equivalent triple and single lines circled
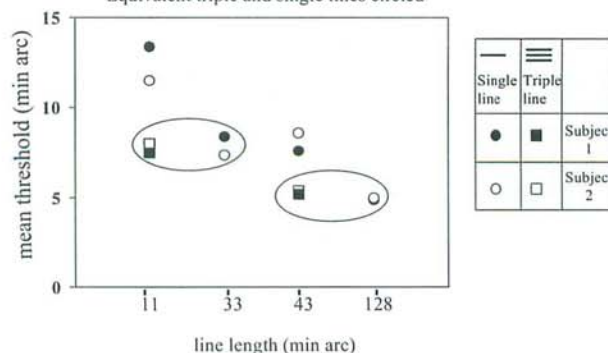
oscillations, duration of 200msec per cycle. Contrast was maintained constant at 84%. Each parameter was tested 3 times, frequency of seeing curves (FOS) were obtained and 50% seen threshold calculated by probit analysis. **Results:** Mean thresholds (min arc) are summarised by chart opposite. **Conclusion:** Equivalent displacement thresholds were found for equivalent lines whether single or distributed amongst 3 shorter lines, indicating spatial summation. This principal may be used to predict motion displacement thresholds when testing within these target dimensions.

This project was supported by an unrestricted grant from Pharmacia.

12.12   **The relation between perimetric and metabolic defects caused by experimental glaucoma**
R. S. Harwerth[1] and M.L.J. Crawford[2] [1]University of Houston, [2]University of Texas – Houston
Houston, TX.

Purpose: Glaucomatous optic neuropathy causes a loss of visual sensitivity and a reduction in the metabolism of neurons in the afferent visual pathway. The purpose of the present investigation was to correlate the visual and metabolic alterations caused by experimental glaucoma. **Methods:** The metabolic activities of neurons in the magno- and parvo-cellular pathways were analyzed in tissue from monkeys with visual field defects caused by laser-induced, elevated intraocular pressures. Visual fields were assessed behaviorally by standard clinical perimetry. The effects on the metabolism of neurons that were topographically related to perimetry defects were determined by cytochrome oxidase histochemistry. **Results:** There was a general qualitative agreement between the loss of visual sensitivity and the percent reduction in cytochrome oxidase reactivity, but the quantitative correlation was modest ($r = 0.3$ for 11 monkeys). The metabolic effects of glaucoma were not significantly different for the magno- and parvo-cellular pathways. **Conclusions:** The results are in agreement with structure-function models that small ensembles of afferent neurons with the highest sensitivity for the stimulus determine visual thresholds, while the density of cytochrome oxidase reactivity is determined by the combined activity of all of the neurons in the sampled site.

Session Four: Comparative Studies

Moderators: Erik Greve, Amsterdam, The Netherlands; Aiko Iwase, Gifu, Japan.

14.00   **SAP SITA and Full-Threshold Strategies Compared to SWAP and FDT in Glaucoma.**
Catherine Boden, Pamela A. Sample, Robert N. Weinreb Visual Function Laboratory, Glaucoma Center, University of California at San Diego, La Jolla, CA.

Purpose: To compare full-threshold (FT) and SITA algorithms for standard automated perimetry (SAP) with SWAP and FDT in glaucoma. **Methods:** 64 patients with glaucomatous optic neuropathy (GON) with SAP (SITA and FT) SWAP and FDT within 3 months were included. Quadrant defects (superior nasal and temporal, inferior nasal and temporal) were defined as at least 1 pattern deviation (PD) point at $p<5\%$. Results: SAP-SITA shows more abnormal PD points than SAP-FT or SWAP. Agreement about field abnormality was good amongst the 4 tests (kappa=0.7 to 0.8). The location of quadrant defects on SAP-FT (kappa=0.3 to 0.5) tended to agree better than SAP-SITA (kappa=0.1 to 0.5) with FDT and SWAP. When agreement was poor, quadrants with a defect on SAP-SITA tended to be normal on SWAP and FDT. **Conclusions:** The SITA algorithm flags points on the PD plots that are not flagged on the other tests.

14.12   **A comparison of SWAP and FDT perimetry in cases of early glaucoma and high-risk ocular hypertensives.** Shaban Demirel, Chris A. Johnson. Discoveries In Sight Research Labs, Portland, Oregon, USA

Purpose: To compare two sensitive measures of visual function, in high-risk ocular hypertensives and patients with early glaucomatous field loss. **Methods:** 33 high risk ocular hypertensives (normal SAP, optic disc or nerve fiber layer abnormality and/or two or more other risk factors [family history, elevated IOP, significant vascular history, African American, older age]) and 33 patients with early glaucoma (SAP defect in one or both eyes consistent with glaucoma, MD no worse than -6 dB) were examined with SWAP and with commercial and 24-2 versions of FDT perimetry. **Results:** Early SAP visual field loss was confirmed by SWAP, commercial FDT and 24-2 FDT 96, 85 and 91% of the time respectively. In ocular hypertensives, visual field damage was evident on SWAP, commercial FDT and 24-2 FDT 10, 48 and 53% of the time respectively. **Conclusions:** FDT perimetry is a sensitive method for detecting early

glaucomatous loss; comparable to SWAP. The use of a larger number of smaller targets improves early detection for FDT. FDT detects visual field abnormality in many high-risk ocular hypertensives; longitudinal analysis will determine whether they convert.

14.24   **Findings of the AAO/VFW Eye Screenings, 1998-2001**
William E. Sponsel, Yolanda Trigo, University of Texas Health Science Center, San Antonio, Texas

Purpose: To evaluate the FDT as a means for detecting visual field loss, relative to Humphrey 24-2, from the cumulative database of four AAO-sponsored eye screenings at the Veterans of Foreign Wars (VFW) National Conventions (1998-2001). **Methods:** All Health Fair attendees underwent acuity and Frequency Doubling Technology (FDT) testing in years 1-4; all eyes also underwent applanation tonometry in year 4. All participants with acuity <20/40 or two or more misses on FDT C-20 underwent tonometry, slit lamp and ophthalmoscopic exam. Humphrey 24-2 perimetry and appalanation tonometry were performed for all eyes failing FDT testing in years 1-4, and, in addition, for all eyes with IOP >21 mm Hg in year 4. Combinations of stereo digital disc imaging (DisCam), GDX nerve fiber analysis, and/or HRT II scanning laser disc analysis were performed on the bulk of those failing the FDT each year. **Results:** 2014 self-referred individuals were screened; ~500 per year (2:1 ratio M:F; mean age 70 yrs); 284 (13%) failed both FDT and HVF, demonstrating nerve fiber layer type scotomata. The cumulative false positive rate for FDT C-20 relative to HVF 24-2 was 5% (16/300). IOP was >20, in either eye, among 17% (47/284) of those failing both visual field assessments. In 2001, when tonometry was performed on all 535 subjects screened (and either an IOP >20 or an FDT failure triggered HVF 24-2 acquisition) the positive predictive value for an abnormal HVF was 13% (9/67) for IOP >20. For FDT it was 97% (65/67). The true positive rate for IOP >20 was 33% (9/27), and for FDT was 92% (65/71). Significant disc abnormalities were present in ~85% of eyes failing both the FDT and Humphrey. Adopting a higher IOP screening cutoff further decreased the net positive HVF yield, with little improvement in true positive rate (8/27 for IOP>23; 6/11 for IOP>24; 5/9 for IOP>25; 4/7 for IOP>26). **Conclusions:** In consecutive self-referral screenings of VFW attendees in San Antonio (1998), Kansas City (1999), and Milwaukee (2000, 2001), very high concordance was found between FDT and HVF findings, with a high preponderance of disc pathology among those demonstrating field loss. IOP screening was reaffirmed as a dismal means for predicting visual field loss, regardless of the IOP cutoff value used. The FDT appears to be a very robust screening tool, readily complimented by rapid on-site neural imaging.

14.36   **SITA Standard and Short-Wavelength Automated Perimetry in the early Glaucoma diagnosis.** G.Milano, F.Montemurro, C.Tiso, A.Clemente, A.D.Fongang, I.Scatassi
Clinica Oculistica dell'Università, I.R.C.C.S.Policlinico San Matteo, Italy.

Purpose: SWAP has been considered more sensitive than Full Threshold Automated Perimetry in detecting early glaucomatous defects. The new algorithm SITA Standard allows a rather fast and accurate evaluation of differential light sensitivity. The aim of the study is to compare SITA Standard and SWAP in detection of early glaucomatous abnormalities. **Methods:** 50 patients (99 eyes) with intra-ocular pressure (IOP) well controlled by topical therapy were submitted to automated perimetry with SITA Standard and SWAP strategies. The visual fields were classified as normal or pathological on the basis of clinical criteria taken from the Guide-lines of the European Glaucoma Society. **Results:** 37 eyes were classified as pathological with SITA 23 with SWAP. In 21 cases the visual field was abnormal only with SITA and in 7 cases only with SWAP. In 16 cases early defects were pointed out with SITA and SWAP either. **Conclusions:** SITA Standard in comparison with SWAP requires less test time with less patients fatigue but with the same or even better test quality and accuracy.

14.48   **Conventional perimetry and Frequency Doubling Technique (FDT).**
Michele Iester[1,2], Michele Altieri[1], Francesca Nasciuti[1], Paolo Vittone[2], Carlo E Traverso[1], Giovanni Calabria[1] 1) Department of Neurological and Visual Sciences, Ophthalmology, University of Genoa, Italy 2) Div of Ophthalmology, G Gaslini Institute, Genoa, Italy.

Purpose: FDT uses a sine wave pattern to create the frequancy doubling illusion testing mainly the magnocellular pathway. The aim was to evaluate the correlation between Humphrey Field Analyzer (HFA) (a standard threshold perimetry) and Frequency Doubling Perimetry. **Methods:** Fifty consecutive glaucoma cases were recruited for this study. Diagnosis of glaucoma was made in each study eye using the European Glaucoma Society terminology : visual field and / or an optic disc damage typical of glaucoma with an IOP on no treatment higher than 21 mmHg and no other reason of optic neuropathy. Visual fields were assessed by both Humphrey perimeter, program 30-2, and Frequency Doubling Perimetry, full threshold C-20. Only patients with visual acuity was better than 20/30 and with realiable visual fields were considered. HFA mean defect (MD), Corrected pattern standard deviation (CPSD) and pattern standard deviation (PSD) and FDT MD and FDT PSD were calculated. Spearman correlation and Mann-Whitney U

test were used. **Results:** The mean age of the studied group was 64 years $\pm$ 2.1 (mean $\pm$ standard deviation). The HFA MD was -5.4 $\pm$ 5.2 dB while FDT MD was -4.7 $\pm$6.2 dB. FDT MD and PSD showed a significant correlation with HFA MD (r=0.60, p<0.001) and HFA PSD (r=0.71, p<0.001) or HFA CPSD (r=0.60, p<0.001). **Conclusions:** The significant quantitative correlation we found is probably explained by the FDT capability to simultaneously challenge contrast, spatial frequency and temporal modulation, all of which are likely to be influenced by blatant glaucomatous ganglion cells dysfunction.

14.52   **Frequency doubling perimetry and high-pass resolution perimetry in glaucoma and ocular hypertension.** Lada Kalaboukhova and Bertil Lindblom. Institute of Clinical Neuroscience, Göteborg University, Göteborg, Sweden

Purpose: To investigate the concordance between Frequency Doubling Technology Perimetry (FDT) and High-Pass Resolution Perimetry (HRP) in eyes with primary open-angle glaucoma, suspect glaucoma or ocular hypertension. **Methods:** Sixty patients (110 eyes) were studied. Visual fields were assessed by HRP, FDT-screening, and FDT-threshold 20-5. For eyes with a discrepancy between the test results a comprehensive clinical examination was performed, including optic disc photography and Heidelberg retinal tomography. **Results:** There was a strong correlation between HRP neural capacity and the FDT score (both screening and threshold). In 49 eyes (45%), HRP, FDT-screening and FDT-threshold were all normal while in 34 eyes (31%) all tests were abnormal. In 13 eyes (12%) HRP was normal and FDT-screening was abnormal while in eight eyes (7%) the opposite was true. The reasons for the discrepancies were analyzed. **Conclusions:** There was a good correlation between FDT and HRP results. FDT is a good screening test for the detection of optic nerve damage in early open-angle glaucoma.

14.56   **Glaucoma diagnosis using Tendency Orientated Perimetry.**
Manuel González de la Rosa, Victor Arteaga, Gustavo Baca, Marta González-Hernández. University of La Laguna. Canary Islands. Spain

Purpose: Looking over the data from a previous research, (Ophthalmology. 2000; 107:134-142) we noticed that the MD had similar diagnostic ability in TOP than in Bracketing, but the LV was better that the MD in TOP and worst in Bracketing. We have studied the ability of several perimetric indexes using TOP. **Methods:** a) 139 visual fields from patients with glaucoma (mean MD=7.5dB, sd=6.7dBdB) and 89 normal subjects examined using TOP-32 and b) 65 glaucomas (mean MD = 6.1dB, sd=2.7dB) and 62 normal subjects examined with G1-TO, were examined using ROC analysis and different criteria: [1] number of points deviated more than 5dB (NPP), [2] MD, [3] sLV (LV square root) and [4] an empirical criteria consisting on the presence of at least 3 out of 7 the following criteria NPP>2, sLV>3dB, MD>6.7dB and sLV in areas S3,S2,I2 and I3 (Arch Soc Esp Oftalmol 77:87-94, 2002) higher than 2.55, 1.76, 2.15 and 2.55dB. **Results:** The results of the TOP-32 study were: specificity 76.4, 65.2, 92.1, 93.5%, sensitivity 91.4, 79.1, 93.5, 97.8%, positive predictive value 85.8, 77.6, 93.5, 98.5%, negative predictive value 85.0, 66.7, 90.1, 90.6%. The results of the TOP-G1 study were: specificity 88.5, 87.1, 98.4, 92.3%, sensitivity 86.2, 89.2, 81.5, 93.5%, positive predictive value 88.9, 87.9, 98.1, 93.8%, negative predictive value 85.7, 88.5, 83.6, 92.1%. **Conclusions:** Although LV values are lower in TOP than in Bracketing, its diagnostic ability is higher than that of the MD. The best results were obtained with the "3/7" index, that takes into account the regional LV at four nasal areas, corresponding to specific ganglion cell axon bundles.
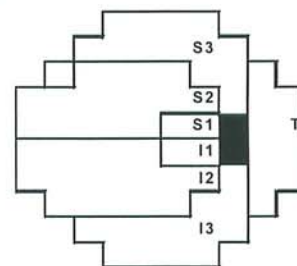
15.08   **Comparison of TOP strategy (Octopus) and SITA Fast (Humphrey) algorithm in damaged visual fields.** Paolo Capris[1], Guido Corallo[1], Piergiacomo Torre[1], Paola Camicione[1], Francesca Nasciutt[1], Marina Papadia[1], Barbara Biasotti[2] Department of Neurological and Visual Sciences – Ophthalmology Unit[1] (University of Genoa, Italy). Department of Health Sciences – Biostatistic Unit[2] (University of Genoa, Italy).

Purpose: The SITA Fast algorithm of the Humphrey Field Analyzer and the TOP strategy of the Octopus perimeter can be considered the shortest available perimetric strategies in fast threshold testing. The algorithms of the two strategies are quite different. The reproducibility (inter-test variability) and the inter-algorithm differences were evaluated in damaged visual fields. **Methods:** Twenty eyes of twenty patients (aged 25-68 years) with damaged visual fields (MD > 8 dB) were examined in two sessions. In the first session each patient was tested with the 32 Program TOP Strategy (Octopus 101 Perimeter, Interzeag Ag). In the same session, after 30 minutes testing time, a second examination was carried out with the central 30-2 program SITA Fast strategy (750 II HFA, Zeiss Instruments). The order of the examinations was randomized. A second session was performed 3 days later, with the same procedure, in reverse order. **Results:** The average inter test point-wise sensitivity difference for the TOP strategy was lower than for

the SITA Fast one (-0.658 dB for TOP and –0.778 dB for SITA Fast) The mean sensitivity error between the first session of SITA Fast and the full threshold HFA strategy (-1.566 dB) was significantly higher (p<0.01) than the error between TOP and the Octopus full threshold strategy (-0.874 dB). The testing time for the TOP strategy (153 sec.) was 57.86 % lower than the SITA Fast (363 sec.). Both strategies reduce testing time (64% SITA Fast, 84% TOP). SITA Fast showed a higher mean sensitivity compared to TOP (+2.959 dB). TOP offers better precision and shorter test duration (the average testing time is almost half, compared to SITA Fast), whereas SITA Fast is characterized by better test-retest reproducibility. **Conclusions:** although the differences between the two ultra-short strategies are statistically significant, they are not clinically manifest. The time saving obtained by TOP or SITA Fast is due to a lower accuracy. These strategies represent an important progress in perimetry, as they realize reliable visual fields with a great time saving.

15.20   **Fast 'TOP' - and normal bracketing strategy in glaucoma**

Fritz Dannheim, Department of Ophthalmology, General Hospital Harburg, Hamburg, Germany.

Purpose: Comparison of visual fields with different degrees of glaucoma-tous alterations, obtained with both strategies, by duration, reproducibility, conformity, mean defect (MD), loss variance (LV), and by inspection. **Methods:** Visual fields of 27 glaucomatous eyes of 21 subjects were examined twice with the normal bracketing and twice with the TOP strategy of the OCTOPUS 1-2-3 perimeter in variable order using program G1X. The fields included 4 borderline, 5 mild, 5 moderate and 13 severe defects. **Results:** Duration with the normal strategy was 11.2 ± 0.68, with the TOP strategy only 2.25 ± 0.18 minutes - a gain in time of 80 ± 2 %. Reproducibility for each of the two strategies, calculated as short term fluctuation (SF), is for the normal strategy 4.04 ± 1.05, for TOP 4.19 ± 1.23. Three eyes with borderline or mild defects had a considerably larger SF for TOP. Reproducibility as correlation coefficient of relative sensitivity values within each strategy is in moderate or severe alterations for both strategies in the same order with values around 0.8 except for one outlier. Conformity of results for both strategies, calculated as SF between the mean values of relative sensitivity for either strategy, is 3.93 ± 0.94, slightly smaller than the within-strategy SF. Conformity as correlation coefficient between mean values of relative sensitivity for either strategy is in eyes with moderate and severe defects in the range of 0.81 to 0.91 (0.84 ± 0.09). The independent regression line of this correlation shows a slope of 0.82 to 0.91, an intercept of 0.35 to 2.93. TOP apparently levels the different defect values mildly reducing LV, whereas MD is equal for both. Inspection shows an excellent to reasonable good coincidence of fields for both strategies in all cases. Fields with moderate or severe defects agreed better than lesser affected ones. The 4 most deviating results are presented, their short term fluctuation lies well within the long term fluctuation. **Conclusions:** The TOP strategy saves 80 % of examination time thus avoiding fatigue. This fast threshold method proved sufficiently reliable for a routine application in glaucoma. A slight attenuation of defect values with TOP calls for a continuous application in follow-up examinations.

15.32   **Comparison of selected parameters of SITA Fast and Full Threshold strategies in evaluation of glaucoma suspects.**
Katarzyna Sokołowska, Piotr Kawa, Tomasz Żarnowski, Magdalena Białek, Zbigniew Zagórski Tadeusz Krwawicz Chair of Ophthalmology and 1st Eye Hospital, Lublin, Poland

Purpose: To determine the differences between selected parameters of SITA Fast and Full Threshold algorithms in glaucoma suspects. **Methods:** Fifty-five eyes of thirty patients (17 men and 13 women, mean age 44 ± 14.9; range 17-71 years) with glaucoma risk factors were included in the study. The risk factors were as follows: ocular hypertension (OHT) – IOP around 30 mmHg (9 patients), OHT and family history (3 patients), OHT and pigment dispersion syndrome (14 patients) and OHT and pseudoexfoliation syndrome (4 patients). Each patient was examined at least twice (random sequence of the tests) with two strategies: SITA (Swedish Interactive Threshold Algorithm) and Full Threshold using the Humphrey Field Analyser and Program 30-2 with appropriate optical correction. Main outcome measures were: test duration, global indices such as Mean Deviation (MD) and Pattern Standard Deviation (PSD) and also reliability indices – Fixation Losses, False Positive and False Negative. Student t-test was used for statistical analysis. **Results:** The mean ($\pm$ SD) test duration was 3 min. 51 sec. $\pm$ 34 sec. for SITA Fast strategy and 12 min. 46 sec. $\pm$ 97 sec. for Full Threshold strategy (p<0.0001). The mean Mean Deviation (MD) was -1.16 ± 1.55dB for SITA Fast strategy and -2.22 ± 2.31 dB for Full Threshold strategy (p=0.0057). The mean Pattern Standard Deviation (PSD) was 1.90 ± 1.11dB and 2.42 ± 1.28 dB, respectively (p=0.027). The mean reliability indices were as follows: Fixation Losses 14.0 ± 14.7% for SITA Fast strategy and 10.0 ± 11.6% for Full Threshold strategy (p=0.12); False Positive was 4.6 ± 4.9% and 3.1 ± 6.8%, respectively (P=0.18); False Negative 1.8 ± 3.4% and 1.0 ± 2.7%, respectively (P=0.18). **Conclusions:** There is a significant reduction of test time for SITA Fast strategy compared with Full Threshold strategy. MD values were lower and PSD values were higher for Full Threshold strategy in relation to those obtained with SITA Fast strategy. Reliability indices did not significantly differ between the two strategies.

Session Five: Clinical I

Moderators: Steve Newman, Charlottesvile, Virginia, USA; Avi Safran, Geneva, Switzerland.

16.15 **Fundus perimetry and mfERG with the SLO in chronic serous retinopathy**
S. Bültmann, K. Rohrschneider. Department of Ophthalmology, University of Heidelberg, D-69120 Heidelberg, Germany.

Purpose: Central serous retinopathy leads to impaired visual acuity accompanied by metamorphopsia. We wanted to evaluate the use of fundus perimetry and mfERG in diagnostics and follow-up in patients with CSR. **Methods:** 10 eyes of 9 patients were examined by automatic static fundus perimetry with Goldmann III targets as well as mfERG using the RETIscan system and the SLO 101 (Rodenstock) for stimulation. Follow-up examinations were performed in 3 eyes of 3 patients. **Results:** Initial visual acuity ranged from 0.2 to 0.6 and recovered to 1.0 in four eyes. Static fundus perimetry showed only minor reduction of threshold values in the area of macular edema in eyes with a short history of disease. In these eyes mfERG was normal. Five patients with a prolonged history of RCS presented with significant reduction of thresholds as well as pathologic mfERG signals. **Conclusion:** Fundus perimetry in combination with mfERG using the SLO is a precise tool for diagnostics and follow-up of RCS. Significantly reduced threshold values in combination with pathologic mfERG signals appear to have a predictive value towards a less favorable outcome while normal mfERG in combination with minimally reduced threshold values seems to go along with restitution. Whether these minor reductions are caused by light scattering in the edematous retina or damaged photoreceptors needs further evaluation.

16.27 **FASTPAC 30-2 vs. TOP-32 in neuro-ophthalmological defects**
J. Morales, C. Sawyer, K.A. Freedman, AS Abdul-Rahim, Texas Tech University HSC,–KKESH, Saudi Arabia

Purpose: To compare the results obtained with Fastpac 30-2 and TOP-32 in patients with neuro-ophthalmological abnormalities. **Methods:** 22 patients referred to the neuro-ophthalmology service underwent both tests the same day. Comparison of global indices, localization of defects and agreement regarding topographic diagnosis was made. **Results:** 43 pairs of visual fields from patients with a variety of neuro-ophthalmological disorders were evaluated. Mean time per eye was TOP:2:29; Fastpac:9:34 . Correlation coefficient was 0.92 (STEYX 2.57) for mean deviation-mean defect (MD). Absolute difference in MD estimation was less than 3,6 and 9 dB in 79, 91 and 100% respectively. Excellent agreement between both strategies was estimated in 11 patients, moderate agreement in 9 and poor agreement in 2. Topographical correlation of the defect corresponded accurately with the defect found by traditional threshold testing especially in those cases with a well defined defect. TOP "smoothed" the edges of sharp scotomas and produced less profound scotomas than Fastpac as described previously. **Conclusions:** TOP is capable of detecting abnormalities and to map out accurately well defined neuro-ophthalmological type of field defects. The smoother edges and shallower scotomas observed with TOP do not seem to impair the ability to make a topographic diagnosis of well defined lesions. Neurological patients might benefit from a short test.

16.39 **Natural course of homonymous visual field defects as a function of lesion location, pathogenesis and scotoma extent.**
M.Baur[1], E.Rohlfs[1], G.Magnusson[1], R.Burth[1], R.Vonthein[2], U.Schiefer[1]. [1]Dept of Neuro-Ophthalmology, University Eye Hospital, Tübingen, Germany; [2]Dept of Medical Biometry, University of Tübingen, Tübingen, Germany.

Purpose: To investigate the natural course of homonymous visual field defects as a function of lesion location, pathogenesis and scotoma extent. **Methods:** The visual field data of 66 patients (36 men and 30 women, age 14 - 80 years) with homonymous visual field defects caused by vascular lesions (38), tumors (8), inflammation (15), and other causes (15) were analysed. The follow up-period was one year in each patient. Perimetric examinations were carried out with threshold oriented slightly supraliminal static grid perimetry (Tuebingen Automated Perimeter [TAP] 30°, 191 test locations). Statistical evaluation was performed with JMP 4.0.2 (SAS Inst. Inc. Cary NC, 2000). We estimated the odds of a test point to be seen versus an absolute defect with a logistic regression model. **Results:** Results regarding all 66 patients show the mean trend of a decline of the visual field defect (Chi-Square [χ^2]=113.27, p<0.0001). Looking at the 38 patients suffering from visual field defects caused by *vascular lesions* the chance for decline decreased from 6.54:1 at baseline (initial) to 6.21:1 after one year, a significant deviation from the mean trend

($[\chi^2]=190$, p<0.0001). Analysing the *locations of the lesion* in all patients, the chance rose (5.8:1 at baseline, 6.9:1 after one year; comparison with mean Odds Ratio (OR): $[\chi^2]=19.98$; p<0.001) in the 38 patients with visual field defects as a result of a lesion in the occipital cortex. This increase was slightly more distinct in the 19 patients suffering from visual field defects caused by lesions of the optic radiation (8.2:1 at baseline (initial), 10.0:1 after one year; comparison with mean OR: $[\chi^2]=13.85$; p<0.001). Sample size of other patient groups (e.g. pathogenesis: inflammation; or location: optic tract) was too small to obtain reliable results. Comparing the upper with the lower hemifield, the chance of decline of the visual field defect rose in both parts (4.3:1 at baseline (initial), 7.8:1 after one year; comparison with mean OR: $[\chi^2]=213.9$; p<0.001 versus 6.5:1 at baseline (initial), 7.7:1 after one year; comparison with mean OR: $[\chi^2]=209.2$; p<0.001). Looking at the 5°, 15°, and 25° eccentricity of the visual field defects chance of (partial) recovery from the visual field defect rose most in the 5° area (6.4:1 at baseline (initial), 10.3:1 after one year) whereas in the 15° and 25° areas the chance of improvement increased only slightly over time (3.7:1 at baseline (initial), 5.4:1 after one year and 3.2:1 at baseline (initial), 4.2:1 after one year, respectively). **Conclusions:** The chance of recovery of a homonymous visual field defect is more likely in the central visual field, the part that is most important for example for reading ability, than in the periphery. Patients whose homonymous visual field defects result from a vascular lesion show a prognosis which is worse than the average.

16.51   **Association between birth weight deviation and visual function** Lene Martin[1], David Ley[2], Karel Marsal[3], Anna-Lena Hård[4], Ann Hellström[4] [1]Dept. of Clinical Science, Karolinska Institutet, Stockholm, Sweden [2]Dept. of Pediatrics and [3]Department of Obstetrics and Gynecology, Lund University Hospital, Lund, Sweden, [4]Dept. of Clinical Neurosciences, Section of Ophthalmology and International Pediatric Growth Research Center, Sahlgrenska University Hospital/East, Gothenburg, Sweden

Purpose: In a recent study it was found that intrauterine growth retardation (IUGR) as reflected by low birth weight for gestational age (> 22% birth weight deviation from normal gestational age) was associated with a low neuroretinal rim area (Ley et al 2002, submitted). In the current study, the influence of IUGR on visual function was evaluated. **Methods:** We studied 23 IUGR subjects and 21 carefully matched normal controls, using letter acuity thresholds, full-threshold Frequency Doubling Technology perimetry (FDT) and the recently developed Rarebit (microdot) Perimetry (RP). **Results:** Mean 50% acuity thresholds differed significantly between the two groups (IUGR = 0.86 minutes of arc, versus controls = 0.77 minutes of arc, p =0.04) as did RP mean hit rates (IUGR = 90% vs controls = 97%, p = 0.02). In FDT, neither mean nor pattern standard deviations differed significantly between the groups (p = 0.22 and 0.07, respectively). **Conclusions:** These data indicate that IUGR is associated with slightly impaired visual function, which can be detected using letter acuity thresholds and Rarebit Perimetry but not using FDT perimetry.

16.55   **Stimulus size in fundus perimetric detection of small scotomata**
K. Rohrschneider, S. Bültmann. Department of Ophthalmology, University of Heidelberg, D-69120 Heidelberg, Germany

Purpose: To perform fundus perimetric examinations of the optic disc as an example for a physiologic scotoma and to correlate stimulus size and intensity with the actual size of the blind spot. **Methods:** We performed kinetic as well as automatic static threshold fundus perimetry using the SLO. Stimulus size was changed from Goldmann I to Goldmann V during the kinetic procedure while threshold was determined during static perimetry using Goldmann I, III, and V stimuli. We included normals as well as glaucomatous eyes (n=10, each). **Results:** As expected, the size of the blind spot enlarged with stimuli of decreasing size. Goldmann V stimuli were recognized in all but 3 eyes. However, the difference between comparable stimuli such as Goldmann V with 15 dB and Goldmann II with 0 dB was very small. There was an enlargement of the disc in glaucomatous eyes especially with pronounced cupping. **Conclusions:** It has been reported earlier using conventional perimetry that the delineation of the blind spot strongly depends on stimulus size. Also, during fundus perimetry there is an effect of light scattering with large stimuli. Therefore the absolute scotoma might not be found with a stimulus such as Goldmann V (1.8 deg diameter) which is small in relation to the diameter of the disc (5-7 deg). Since the enlargement of the blind spot in glaucomatous eyes does not result from stimulus size, light scattering is only of minor importance during scanning laser fundus perimetry.

Friday 28th June

Session Six: Electrophysiology

Moderators: Chris Johnson, Portland, Oregon, USA; David Crabb, Nottingham, UK.

08.45   **Detection of glaucomatous visual field loss using multifocal VEP**
B. Fortune, K. Goh, S. Demirel, K. Novitsky, G. A. Cioffi, C. A. Johnson. Discoveries in Sight, Devers Eye Institute, Portland, OR, USA

Purpose: To evaluate a new multifocal VEP system for its ability to detect glaucomatous visual field loss in a clinical setting. **Methods:** Multifocal VEPs were recorded using the OPERA (v2) system (ObjectiVision Pty, Ltd, Sydney, AUS) in both eyes of 38 patients with glaucoma and 48 control subjects (see ref.1 for detailed methods). Glaucoma diagnosis was based upon optic disk appearance (glaucomatous optic neuropathy in at least one eye) and/or visual field loss measured by standard automated perimetry (SAP; $p<0.05$ for MD, PSD, or CPSD; or GHT outside normal limits) confirmed in at least one eye. Controls had normal visual fields (by above criteria) and normal optic disk appearance in both eyes. All visual fields were required to be reliable: fixation losses, false positives and false negatives <33%. Sensitivity and specificity levels were determined for various criteria using the OPERA internal normative database. **Results:** SAP visual field mean defect ranged from 1.8 to –28.6 dB (mean –8.0, SD 7.6). At a fixed specificity level of 95%, sensitivity for detection of an abnormal SAP VF was 89% and 91% based on the number of abnormal VEP points (max 58 possible per eye) below the $p=0.02$ and $p=0.01$ level, respectively. Using the "abnormality index" (proprietary algorithm uses weighted combinations of above, interocular asymmetry, and clustering factors), sensitivity was 85% at 95% specificity. Using our own simple criteria of 3 or more clustered points at $p<0.01$ for monocular amplitudes or $p<0.001$ for interocular asymmetry, sensitivity was 94% and specificity was 100%. **Conclusions:** The OPERA mfVEP system can be used to detect glaucomatous visual field loss with reasonably high sensitivity and specificity. Although control subjects commonly have isolated "defects" on the OPERA mfVEP, they are rarely clustered. 1. Goldberg I, Graham SL, Klistorner AI. *Am J Ophthalmol.* 2002;133:29-39.

08.57   **The multifocal visual evoked response in neuro-ophthalmologic disorders**
M. Wall and K.R. Woodward. Veterans Administration Hospital and University of Iowa, Iowa City, IA, USA.

Purpose: To validate Multifocal Visual Evoked Potential testing (MfVEP) in patients with neuro-ophthalmologic disorders. **Methods:** We tested 13 patients with documented lesions of the central visual pathways. Ten had optic neuropathies and three had hemianopias. All patients had Humphrey or Goldmann perimetry and MfVEP using the Opera system. Visual field defects were defined for both tests as having three contiguous abnormal test locations at the $p <0.05$ level or worse in a clinically suspicious area. Amplitude not latency information was used for the analysis. **Results:** We found the MfVEP showed similar deficits to conventional perimetry testing in 12 of 13 patients. In particular, nerve fiber bundle defects were well demonstrated as were hemianopic defects. Multiple examples will be shown. **Conclusions:** The MfVEP is a reliable test to detect visual field defects of the central visual pathways.
Supported by a VA Merit Review   No Proprietary Interest

09.09   **Multifocal Visual Evoked Potential and functional visual loss**
K.R. Woodward and M. Wall. Veterans Administration Hospital and University of Iowa, Iowa City, IA, USA.

Purpose: To investigate the usefulness of Multifocal Visual Evoked Potential testing (MfVEP) in patients with functional visual loss. **Methods:** Four patients, ages 16 – 54 (mean age 33.3), with clinical presentations typical of functional visual loss were tested with MfVEP. All patients had complete neuro-ophthalmologic examinations. Goldmann and Humphrey perimetry examinations and MfVEP results were compared. **Results:** The MfVEP test demonstrated robust evoked potentials in areas of visual field "loss" with Goldmann or Humphrey perimetry in all 4 patients tested. All patients showed severe visual field loss with Goldmann perimetry which was not supported by other clinical evidence. MfVEP was able to clearly record strong signals in the area of reported loss.
Conclusions: MfVEP is a useful clinical tool in determining functional visual field loss.
Supported by a VA Merit Review.
No Proprietary Interest.

09.21 **Study of the VEP and F-ERG in Apply of Ocular Contusion**
Ding Ying. Department of Ophthalmology The First People's Hospital of Yingchuan, China.

Purpose: to evaluate the visual function of patients with ocular contusion by visual evoked potentials (VEP) and flash electroretionogram (F-ERG). **Methods:** 86 cases (86 eyes) with ocular contusion and their flow eyes worked as control group. VEP and F-ERG were recorded respectively according to ISCVE standard. The P_{100} latency and amplitudes of VEP, amplitudes of F-ERG$_{a,b}$ - wave were analysed. **Results:** The amplitudes of VEP and F-ERG was increased. **Conclusions:** VEP and F-ERG were the objective examining methods on early diagnosis of ocular contusion and visual function assess.

Session Seven: New Techniques I

Moderators: Peter Åsman, Malmo, Sweden; David Henson, Manchester, UK.

09.25 **Second generation of the Tendency Orientated Perimetry algorithm in glaucomatous patients**
Fátima Mesa, José Aguilar, Marta Gonzalez-Hernandez, Manuel González de la Rosa, University of La Laguna. Canary Islands. Spain

Purpose: To compare the results of the second generation of the Tendency Oriented Perimetry Algorithm that uses equations for the dependence of close and distant points specific in glaucoma (TOP Plus-G) with conventional Bracketing perimetry in Glaucoma patients. **Methods:** 49 glaucoma patients at different stages of the disease were examined with both techniques using the Octopus 1-2-3 perimeter. One eye per subject was examined, previous perimetric experience was required and random order was used for the examinations. **Results:** Correlation coefficient (and error of estimation of Y in relation to X) between both examinations was MD=0.97 (1.88dB), sLV=0.88 (1.21dB), MD (Supero Nasal) =0.97 (2.42dB), MD (Infero Nasal) =0.95 (2.60dB), MD (Supero Temporal) =0.93 (2.89dB), MD (Infero Temporal) =0.96 (1.98dB), local thresholds=0.84 (5.51dB). Mean MD value was 11.23 (sd=7.48dB) for TOP+ and 11.59 (sd=7.48dB) for Bracketing (p=0.41). Mean sLV value was 5.73 (sd=2.6dB) for TOP+ and 5.72 (sd=2.51dB) for Bracketing (p=0.49). RMS error for TOP+ in relation to Bracketing increased from 3dB for MD=0dB to 8dB for MD=15dB. In cases with nasal steps, TOP+ precisely delimited the border of the defect, without invading the opposite quadrant. **Conclusions:** TOP+ produces results that are equivalent to TOP with better delimitation of the borders of the nasal step. As opposed to TOP, TOP+ tends to give LV results equivalent to those given by Bracketing.

09.29 **Combined spatial, contrast and temporal functions perimetry in early glaucoma**
Marta González-Hernández, Augusto Abreu, Manuel Sánchez, Manuel González de la Rosa
University of La Laguna. Canary Islands

Purpose: To evaluate the diagnostic ability of a new perimetric procedure (Octopus Pulsar) that utilizes stimuli combining spatial resolution (SR), contrast (C) and motion or pulse, in early glaucoma. **Methods:** Pulsar shows white round stimuli, 5° in diameter, 500msec long, shaped as a wave decreasing in amplitude, in 66 locations of the visual field. The stimuli scale combines SR and C in 36src units. 56 normal and 82 ocular hypertension and glaucoma eyes (one per subject) with Mean Defect (MD)<7dB in white-white Octopus 1-2-3 standard perimetry (WW) were included. Out of these 82 cases, 29 did not show WW perimetric defect (Level 0) and 53 were grouped in 3 levels, depending on the criteria used for perimetric diagnosis, being level 3 the group with worse visual field loss. Two stimuli types were used: one with centrifugal wave motion at 8cyl/deg (K6W) and another with pulse at 30Hz (T30W). **Results:** Mean examination time was 3:49min. Specificities were 96.4% (T30W) and 94.6% (K6W) for a cutoff level of MD=3src. Sensitivities for Level 0 were 34.5% (T30W) and 24.1% (K6W). The Receiver Operating Characteristic (ROC) curve areas for T30W at Levels 1, 2 and 3 were 0.88, 0.94 and 0.99. Sensitivities were 69.8, 82.9 and 100%. The ROC areas for K6W were 0.83, 0.91 and 0.97. Sensitivity for Level 3 was 75%. There was good correlation between both Pulsar perimetries (r=0.88), but it was lower with WW (r=0.58 for T30W and r=0.59 for K6W). **Conclusions:** T30W perimetry may show manifest glaucomatous damage earlier than conventional luminous threshold perimetry.

09.41   Perimetric Measurement of Contrast Sensitivity Functions

Marta González-Hernández, Ana M Fernández-Vidal, Julián García-Feijoo, Manuel González de la Rosa, University of La Laguna. Canary Islands. Spain and Complutense University. Madrid.

Purpose: To measure the Contrast Sensitivity Functions in the central visual field on normal subjects. **Methods:** 20 eyes from 20 normal subjects were examined with 12 types of contrast perimetry for different spatial resolution levels (0.5 to 6.3 cycles/degree), to establish the contrast sensitivity curves in relation to spatial resolution for each point in the visual field. The Tendency Oriented Perimetry (TOP) strategy was used on the Pulsar Perimeter. 66 points of the central visual field (30° nasal and temporal and 24° superior and inferior) were studied. **Results:** The contrast sensitivity functions at the different regions of the visual field fall in a parallel fashion, moving towards higher spatial resolution levels with eccentricity. Contrast thresholds fall very slowly for low spatial frequencies between 0.5 and 1.3 cycles/degree. At 30 degrees, threshold values fall progressively for frequencies higher than 1.3 cycles/degree. Its value for 6.3 cycles/degree in the nasal field is just 2.5% than that for 0.5 cycles/degree. It goes down to 6.8% in the temporal visual field. As a whole, the temporal inferior quadrant had a sensibility 10% higher than the other three, with significant differences for spatial resolutions between 0.5 and 2.5 cycles/degree ($p<0.05$ for student t test). **Conclusions:** The shape of Traquair's representing contrast sensitivity functions, depends on the spatial resolution used. It shows smooth slopes for low spatial resolutions and marked slopes for high ones.

09.45   Pulsar perimetry: a new strategy for early glaucoma evaluation (preliminary findings)

Fernández-Vidal A, García-Feijoó J, García-Sánchez J. Hospital Clínico San Carlos, Madrid, Spain.

Purpose: To evaluate our first results with Pulsar perimetry in patients with ocular hypertension. **Methods:** Pulsar perimetry is a new perimetric procedure which uses stimuli combining spatial resolution (SR) and contrast (C) for early glaucoma evaluation. The prototype examines visual functions which theoretically excite large ganglion cells: a temporal modulation program was used. We studied 35 left eyes of 35 patients with ocular hypertension and normal G1 Octopus perimetry (mean age: 59,63 SD 10,32) and 30 left eyes of 30 normal individuals (mean age: 49,17 SD 18,24). Exclusion criteria: visual acuity <0.8, refractive defect >3 spheric dp or 1,5 astigmatic dp, pupil size <3 mm, ocular surgery or pathologies, and non controlled diseases. They all had previous perimetric experience. Results were analyzed with student t-test. **Results:** For normal individuals, mean sensitivity (MS) for Pulsar perimetry was 21,2 src (spatial resolution and contrast units) with an SD of 2,93. Mean defect (MD) was 0,9 src SD 1,94 and loss variance (LV) was 6,48 src DS 5,4. For patients with ocular hypertension: MS was 18,25 src SD 2,73; MD was 2,92 src SD 2,32 and LV was 9,3 src SD 5,8. MS, MD and LV differences between the two groups were statistically significant ($p<0,05$) with 95% confidence limits of (1,54;4,36), (-3,08;-0,94;) and (-5,62; -0,24) respectively. Area under ROC curve obtained was of 0,78.
Conclusions: Pulsar perimetry may have greater sensibility for the detection of early defects in patients with ocular hypertension than conventional perimetry.

09.57   CLIP-strategy compared to Full Threshold strategy in glaucoma patients

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Purpose: CLIP (continuous light increment perimetry) is an improved testing strategy for automated static perimetry designed to save test time and enhance patient compliance. Stimulus intensity is continuously increased according to patient reaction time, starting from a subthreshold intensity (3dB more than presumed threshold) until recognition. The test in constantly modified according to patient performance. As CLIP showed good results in normal subjects in previous studies, we now compared CLIP to the standard 4/2-full threshold (4/2)-strategy in glaucoma patients. **Methods:** 32 patients with glaucomatous visual field defects (mean sensitivities 2.7 to 20.6 dB), all with perimetric experience were tested with CLIP and 4/2 in a randomised fashion. Tests were performed at 55 test locations within the central 30° visual field (24-2 area) using the Twinfield-perimeter. Mean sensitivity, scotoma detection, differences at single test locations, and test time were compared between CLIP and 4/2. **Results:** Average mean sensitivity was significantly higher for CLIP (13.0dB) than for 4/2 (11.5dB) (ANOVA). Topographic analysis of grey scales showed similar scotoma detection in all patients. The mean difference between CLIP and 4/2 at single test points (excluding the blind spot) was 3.8dB, 75% of differences were less than 6dB, 95% less than 12dB. Mean test time was also significantly shorter (ANOVA) for CLIP (5.5min) compared to 4/2 (8.8min). **Conclusions:** Mean sensitivities for CLIP are 1.5 dB higher than for 4/2, similar results were found previously in normal subjects. Absolute scotomas and extension of scotoma were similar for both strategies. CLIP, therefore, showed comparable results to 4/2 with shorter testing times and good patient acceptance.

10.09   **Novel 3D computer-automated threshold Amsler grid test**

Wolfgang Fink[1,2] and Alfredo A. Sadun[2] [1]California Institute of Technology, Pasadena, CA, USA [2]Doheny Eye Institute, Keck School of Medicine, University of Southern California, Los Angeles, CA, USA

Purpose: To introduce a novel 3D visual field test, developed by Fink and Sadun, that allows for an unprecedented characterization of the structure of visual field defects in three dimensions (see *http://www.wfbabcom5.com/wf335.htm*). **Methods:** With one eye covered the patients are placed in front of a touch-sensitive computer screen at a fixed distance. While focussing on a varying central fixation marker the patients trace with their finger the areas on an Amsler grid that are missing from their field of vision. Increasing degrees of contrast of the Amsler grid are simulated by repeating the test at different greyscale levels. The results are recorded and later displayed as topographical contour rings by the computer test program, resulting in an immediate 3D depiction of the central hill-of-vision. **Results:** Several clinical studies have been conducted at the Doheny Eye Institute and over 200 patients have been examined so far. Conditions such as optic neuritis, anterior ischemic optic neuropathy (AION), age-related macular degeneration (ARMD), glaucoma, and ocular hypertension have been successfully detected by the 3D visual field test. **Conclusions:** The 3D computer-automated threshold Amsler grid test is an innovative, non-invasive, accurate, sensitive, and fast (4-5 min. per eye) visual field test. It provides several advantages over state-of-the-art standard automated perimetry, including: a) additional information through 3D rather than 2D depiction of scotomas, such as location, extent, slope, depth, and shape; b) superior angular resolution (1° compared to typically 6°); c) simple test-setup (merely a touch-sensitive computer monitor and the test software); d) excellent patient compliance. In light of its promising initial tests, the 3D visual field test has the potential for the early detection and monitoring of various diseases over time, in particular but not limited to glaucoma and macular degeneration.

Session Eight: Clinical II

Moderators: Fritz Dannheim, Hamburg, Germany; Dick Mills, Lexington Kentucky, USA.

10.45   **Visual field after pars plana vitrectomy and internal limiting membrane peeling**

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Purpose: To determine the effect of removal of the internal limiting membrane (ILM) on central visual function. **Methods:** In a prospective study, 22 eyes of 22 patients underwent vitrectomy for idiopathic macular hole (8 cases), macular pucker (10 cases) or diabetic macular oedema (4 cases). Surgery consisted of a standard three-port vitrectomy, induction of a posterior hyaloid separation and removal of epiretinal membranes, including the ILM. Staining with 0.5% ICG was obtained to help the ILM identification during surgery. In addition to the clinical examination (including visual acuity and reading speed measurement), static perimetry, using a Humphrey HFA II (10-II and 24-II program) or an Octopus 101 (M2 and 32 program), and kinetic perimetry were performed pre and 3 and 8 weeks post operatively. **Results:** Significant visual acuity and reading speed improvement were recorded in most of these cases. In 7 patients (31%) new paracentral scotomata, mostly asymptomatic, were observed postoperatively. **Conclusions:** The prevalence of peripheral visual field defects was less than 5%. Paracentral scotomata might be caused by a trauma to the nerve fibers during ILM peeling.

10.49   **Influence of optic disc appearances and diurnal variation of intraocular pressure on visual field defects in normal tension glaucoma.**

Y. Yamazaki, T. Nakagami, T. Oshida, K. Mizuki, F. Hayamizu, C. Tanaka. Department of Ophthalmology, Nihon University, Tokyo.

Purpose: To investigate the influence of optic disc appearances and diurnal variation curve of IOP on the visual field defect in NTG. **Methods:** Optic disc stereo photographs of 212 patients with NTG were classified into the four different optic disc appearances: focal ischemic (FI) discs, senile sclerotic (SS) discs, generalized enlargement (GE) of cup discs, and myopic (MY) discs. The pattern of diurnal variation curves of IOP was divided into double-hump type, morning type, day type, night type, and flat type. The clinical charts of the selected patients were reviewed for their automated visual fields and clinical characters. **Results:** Thirty patients with FI discs, 16 with SS discs, 57 with GE discs, and 36 with MY discs were selected. There was no significant difference in MD among the four groups (ANOVA, p=n.s.). MY group showed significantly larger in axial-length and CPSD than those with the other three groups (ANOVA, p=0.000). In diurnal variation curves of IOP, FI group was frequently divided into night type,

SS and GE groups into day type, and MY group into flat type. There was significantly difference in pattern of diurnal variation curves of IOP among the four groups (χ^2 test, p=0.034). **Conclusions:** NTG patients with different disc appearance showed differences in diurnal variation curves of IOP, visual field defects, and clinical characters. These findings suggest that NTG has different pathogenic mechanisms according to the type of optic disc appearances.

10.53 Does patient education result in more reliable initial visual fields?

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Purpose: Many hospital eye departments in the UK have introduced technician-led "fast track" type screening clinics to differentiate between a diagnosis of glaucoma and "non-glaucoma". Traditionally an evaluation of the visual field has formed an important part of this initial assessment. The existence of a significant learning effect for a proportion of patients is well established and equivocal perimetric results from such individuals confound attempts at early discharge. We investigated the effect of postponing the first visual field test until after patients have been seen for assessment and counselling in the screening setting and at a subsequent physician consultation. **Methods:** The cohort comprised two groups of patients referred with a possible diagnosis of glaucoma. Group 1 (n= 103) had visual fields at the first screening visit, Group 2 (n= 93) had a screening visit followed by a physician consultation followed by a third visit for visual fields alone. **Results:** The FASTPAC Program 24-2 fields were assigned as "normal", "abnormal", "equivocal - probably abnormal" and "equivocal – probably normal". The results for the two groups were (Group 1 vs Group 2): "normal" 16 vs 14, "abnormal" 19 vs 23, "equivocal - probably abnormal" 42 vs 33, "equivocal – probably normal" 26 vs 23. No differences were statistically significant. **Conclusions:** Our educational intervention did not result in a higher proportion of reliable fields. If patients are to be discharged from "one-stop-shop" type glaucoma clinics then the role of visual fields may need to be challenged.

10.57 TOP perimetry in children with ocular abnormalities

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Purpose: To assess the usefulness of TOP-32 strategy in children with ocular abnormalities.
Methods: Subjects were recruited in a consecutive fashion from our pediatric ophthalmology clinic. Thirteen healthy, neurologically normal children with congenital or acquired abnormalities of the globe or optic nerve of one or both eyes were included. The TOP-32 program on the Octopus 1-2-3 perimeter was performed twice on each eye. We compared the visual field defect(s) with the anatomic lesion(s), looking for correlation between the predicted and actual scotomas in terms of location, depth and reproducibility. **Results:** The mean test duration was 2:41 seconds (median 2.29sec). A good to moderate correlation between the anatomic abnormality and the visual field abnormality was found in 11 out of 13 patients. Agreement between visual field results and clinical abnormality was higher in patients with unilateral disease and/or a well defined anatomic defect. **Conclusions:** TOP perimetry is useful to detect visual field defects in children with abnormalities of the eye or optic nerve. Test time per eye is under 3 minutes. In a typical clinical setting, a short TOP-32 test performed twice on each eye seems adequate to obtain useful information without boredom or fatigue invalidating the results. Anatomically well-defined ocular abnormalities and/or unilateral disease seem to be easier to characterize and interpret.

11.01 Automatic Static Perimetry in the Young Pediatric Group: Lessons from the Nintendo Generation

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Purpose: To review the utility of automated static perimetry as a means of assessing the extrafoveal function in the young pediatric age group, a retrospective case controlled series was assembled from files at the University of Virginia. Previous studies have demonstrated the ability of young children to perform automated static perimetry, but we were unaware of any attempts to apply this in a clinical setting. **Methods:** 60,000 automated fields stored at the University of Virginia were screened for children of 10 years of age or younger. A total of 180 patients were selected. These patients had undergone a total of 538 visual fields. Fields were assessed for pattern of defect, reliability coefficients, and duration. Diagnoses were compared with results. **Results:** Most common diagnoses included hydrocephalus and papilledema, closed head injury and anomalous disc. Visual field patterns most frequently included arcuate defects, diffuse depression in sensitivity, and homonymous hemianopsia. Of the 52 fields run SITA Fast, duration ranged from 2:39 to 7:34 with a mean of 4:065. This contrasted with a duration of between 3:23 and 25:21 when run Full Threshold (mean > 12 minutes). Of the 431 24-2 programs run with Full Threshold strategy, 104 were identified as nonreliable based on fixation loss, false positives, or false negatives. In addition, 12 visual fields were uninterpretable in spite of acceptable reliability coefficients. This

contrasted with a total of 5 of the 52 SITA Fast fields being identified as having greater than 1/3 false positives or false negatives. If the criteria was tightened to 27%, only 8 of the 52 fields were unacceptable. **Conclusions:** Children of 10 or less are often capable of performing extraordinarily well on standard automated static perimetry. The introduction of SITA allows a tremendous decrease in the duration of the test with subsequent improvement in reliability coefficients. A subgroup of patients, particularly those who are ill or with severe optic nerve or visual pathway pathology, remain poor candidates for automated perimetry. In particular, problems maintaining attention and fixation remain paramount. Automated static perimetry is an appropriate standard extrafoveal function assessment even in very young children.

11.05   **Relationship between retinal contraction and metamorphopsia scores in patients with epiretinal membranes**

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Purpose: To investigate the progress of retinal contraction and metamorphopsia scores using M-CHARTS™ in patients with epiretinal membranes (ERM). **Methods:** Using M-CHARTS™ we developed, we quantified changes in the metamorphopsia scores in 24 eyes of 24 patients with ERM. Follow-up periods ranged from one to 2.1 years (mean: 1.3 years). In order to quantify the retinal contraction due to ERM, we composed the fundus photograph images and evaluated the movement of the retinal vessels during the observation periods. **Results:** There was a significant correlation between the degree of retinal contraction and metamorphopsia score. Increase of metamorphopsia scores was observed in 6 patients during the follow-up periods. Increase of metamorphopsia scores and decrease of visual acuities was observed in 2 patients. Only one patient showed a decrease of visual acuity without increase of metamorphopsia score. **Conclusions:** M-CHARTS™ is a simple and useful method for the detection and follow-up of the metamorphopsia in patient with ERM.

11.17   **Prevalence and characteristics of central binocular visual field defects in patients attending a glaucoma perimetry service**

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Purpose: To estimate the prevalence and distribution of binocular visual field defects in a population attending for glaucoma perimetry using the Integrated Visual Field (IVF) constructed from merged monocular results.[1] [2] **Methods:** All Humphrey visual field tests performed between 16 January 1985 and 6 August 1997 in the Glaucoma Service of Moorfields Eye Hospital were examined. Reliable fields (FL < 20%, FP and FN < 33%) with a white-on-white size III stimulus and 24-2 or 30-2 strategy were selected. The first 2 fields for each eye were ignored to obviate learning effects. IVFs were then constructed if a patient had both eyes tested on the same day. On the rare occasions when a patient had more than one field test on each eye in the same day (39 out of 15912 tests) the two monocular fields done earliest in the day were chosen. IVF defects were defined as <10dB: IVF locations corresponding to either physiological blindspot were excluded from analysis. **Results:** IVFs were constructed for 2567 patients. Of these, 1523 (59.3%) had defects anywhere in at least one IVF, 518 (20.2%) were within the central 20 degrees and 200 (7.8%) were in one of the 4 paracentral locations. Of this last group, 15 patients had isolated IVF defects in the paracentral region: these defects would be missed by the Humphrey Esterman test: 12 of these 15 patients had visual acuities of 6/12 or better. **Conclusions:** One in five of the population studied would have been likely to produce an Esterman test incompatible with legal fitness to drive in the UK. Conversely, a number of patients are likely to have isolated binocular scotomas adjacent to fixation which would be missed by the Esterman test and measures of visual acuity.

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11.29 **Intraocular pressure and visual field loss relationships in primary open angle glaucomas**

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Purpose: To compare the correlation between visual field loss (VFL) and pre-treatment intra-ocular pressure (IOP) in primary angle closure glaucoma (PACG) and primary open angle glaucoma (POAG). **Methods:** Cross-sectional observational study of 74 patients from a prospective randomised controlled trial of trabeculectomy. Visual field testing was with the Humphrey Mk II, 750, full threshold 24-2. A minimum two tests with: mean deviation within 2dB, fixation losses <20%, false +ve's <20% and false -ve's<33%. Subjects with previous symptomatic acute angle closure glaucoma, normal tension glaucoma, and visually significant cataract were excluded. Pre-treatment IOP at presentation, before treatment. The severity of VFL was assessed by AGIS score, Mean Deviation (MD), Pattern Standard Deviation (PSD), and Corrected Pattern Standard Deviation (CPSD). **Results:** There was a stronger correlation between pre-treatment IOP and VFL in PACG (MD: Pearson correlation coefficient, $r = 0.43$, $p= 0.002$: $r2 = 0.19$ and AGIS: $r =0.41$, $p = 0.003$; $r2 = 0.17$) than in POAG (MD: $r =0.21$, $p=0.13$: $r2 = 0.04$ and AGIS: $r = 0.23$, $p = 0.19$; $r2 = 0.05$). **Conclusions:** This may be consistent with the hypothesis of a greater IOP dependence for optic nerve damage in PACG than POAG, and conversely a greater importance of other non-pressure dependent mechanisms in POAG compared to PACG.

11.33 **Comparison of the Caprioli's decibel criteria and the Anderson's probability criteria for detection of early glaucomatous defects with SITA**

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Purpose: To determine whether the results of HFA 30-2 measurement is within normal limit or not, both the sensitivity decrease (Caprioli 1991) and the probability score (Anderson 1992) are in use. Little is known how the results of SITA measurements compare when they are interpreted according to sensitivity decrease and the probability score. **Methods:** A total of 47 eyes of 47 glaucoma patients with mild VF defects, i.e., MD -3.98 +/- 6.06 dB, were tested with the 30-2 Full Threshold strategy, SITA Standard (SS) and SITA Fast (SF) of the Humphrey Field Analyzer (HFA) in random order on the same day. Setting the results with the Standard Full Threshold strategy as the gold standard , two common criteria, i.e., Caprioli's decibel criteria (1991) and Anderson's probability criteria (1992), were applied for the Two SITA strategies. **Results:** The Caprioli's strict criteria: the sensitivity, SS: 78.6% and SF: 71.4%, and the specificity, SS: 89.5% and SF: 89.5%. The Anderson's Criteria: the sensitivity, SS: 92.9% and SF: 96.4%, and the specificity, SS: 89.5% and SF: 78.9%. **Conclusions:** SITA should be judged based on the probability symbol, but not on the threshold value.

11.37 **A relative afferent pupillary defect is an early sign of optic nerve damage in glaucoma**

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Purpose: Early detection of optic nerve damage in glaucoma is difficult. A substantial loss of ganglion cell axons is needed before visual field defects or visible retinal nerve fiber layer atrophy can be detected. Given the fact that a relative afferent papillary defect (RAPD) can be seen already with less than 10 per cent difference in neural input between the eyes, and that glaucoma almost always starts asymmetrically, test of RAPD should be a sensitive way of detecting glaucoma in an early stage. **Methods:** The presence of RAPD was determined in 33 patients undergoing high-pass resolution perimetry (HRP) and Heidelberg retinal tomography (HRT) because of suspect or manifest glaucoma. HRT, and clinical examination including optic disc photography, 19 patients were judged to have glaucoma in at least one eye. All had RAPD. In addition, two patients with ocular hypertension had RAPD. In one, RAPD could not be confirmed on a second test three months later. The other had been treated with steroids due to polymyalgia rheumatica five years earlier and difference in pupil reactions was noted then. **Conclusion:** A test of RAPD is a sensitive, simple and inexpensive way of detecting early optic nerve damage and should be performed in all patients suspected of having glaucoma.

Session Nine: Imaging II

Moderators: Bill Hart, St Louis, USA; Uli Schiefer, Tubingen, Germany.

11.49 Evaluation of effectiveness of new GDx parameters

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Purpose: We evaluated the effectiveness of new GDx parameters for the diagnosis of glaucoma by comparing with the results of currently used parameters. **Methods:** Thirty-three eyes of 33 glaucoma patients (POAG 12 eyes, NTG 21 eyes) and 33 eyes of 33 normal persons were studied (mean age: 59.4 years). Three consecutive measurements of peripapillary retinal nerve fiber layer (RNFL) were performed by a single operator using the Nerve Fiber Analyzer (GDx), and the mean values of three images were calculated. The new GDx parameters used for evaluation were ellipse standard deviation (ESD), normalized superior ratio (NSR), normalized inferior ratio (NIR), discriminant analysis (LDF) and sector analysis (SA). For comparison, fundus photography and 24-2 program of the Humphrey Field Analyzer (HFA) were performed on all subjects. **Results:** All the new GDx parameters had better sensitivity and specificity compared with the currently used parameters except The Number. The sensitivity of LDF was 97% and was the most sensitive among all the parameters studied, but the specificity of LDF was lower than that of The Number. For SA, if glaucoma is defined as having more than one abnormal sector, then the fundus photography was higher in the inferior part of the disc than in the superior part, and the correlation was significant in the inferior part ($p<0.05$). Significant correlations were observed between new GDx parameters and mean deviation (MD) of the HFA ($p<0.01$). In the comparison between early (MD>-5 dB) and moderate or advanced (MD<-5 dB) glaucoma cases, LDF and the Number showed less differences in sensitivity than the other parameters. **Conclusions:** Compared with currently used parameters, the new GDx parameters, especially LDF, were effective for the diagnosis of glaucoma.

12.01 Reproducibility of Heidelberg Retina Flowmeter by AFFPIA

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Purpose: To evaluate the intraobserver reproducibility of a software designed to assess retinal blood flow with Heidelberg Retina Flowmeter (HRF). **Methods:** Ten subjects were consecutively recruited in the study. One eye for each patient was randomly selected. Blood flow measurements were analyzed by using an automatic full field perfusion image analysis (AFFPIA) program. AFFPIA calculates the Doppler frequency shift and the heamodynamic variables: flow, volume and velocity for each pixel. The resulting perfusion image is processed with respect to underexposed and overexposed pixels, saccades, and retinal vessel tree. Intraobserver reproducibility was calculated for AFFPIA program. All the optic nerve heads (ONHs) were horizontally divided into three sections (superior, central and inferior section). The retinal blood flow was calculated in the superior and inferior section, furthermore each section was divided into three parts: the temporal area, the nasal and the rim area. The blood flow was evaluated for each area. **Results:** When the same observer analyzed the same image 5 times (intraobserver intraimage reproducibility), the AFFPIA coefficient of variation (COV) ranged from 0.5% to 5% in the temporal area, from 0.1% to 5.3% in the nasal area and from 0.5 to 28% in the rim area. When the same observer analyzed three different images of the same section once (intraobserver interimage reproducibility), the AFFPIA COV of flow measurements was ranging from 1% to 7.3% in the temporal area, from 1.5% to 10% and from 2 to 30% in the rim area. **Conclusion:** Retinal blood flow measured by HRF and analyzed by AFFPIA had good intraobserver reproducibility. The reproducibility was significantly better in the temporal and nasal area rather than in the rim area.

12.04 Combining Structural and functional assessment to detect glaucoma

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Purpose: To assess whether combining results of scanning laser polarimetry (SLP), optical coherence tomography (OCT), confocal scanning laser ophthalmoscopy (HRT), short wavelength automated perimetry (SWAP) frequency doubling technology (FDT) can improve the detection of glaucoma. **Methods:** Thirty eight healthy eyes and 56 eyes with early to moderate glaucoma were included. Two definitions of glaucoma were used; glaucoma based on repeatable abnormal result on standard automated perimetry (SAP) (n=42) and glaucoma based on optic disc appearance assessed by masked assessment of

stereoscopic optic disc photographs (n=51). Sensitivities and specificities were calculated for each instrument separately and in combination with one additional instrument. **Results:** At a fixed specificity of ≥ 90%, the sensitivies for detecting glaucoma for the best parameters for each instrument were: OCT inferior quadrant thickness (diagnosis based on disc: 69%, diagnosis based on field: 79%), FDT number of total deviation plot points (51%, 48%), HRT RNFL thickness in the temporal/inferior region (55%, 62%), SLP linear discriminant function (33%, 33%), SWAP PSD (41%, and 52%). The best OCT parameter combined with the best parameter from either SLP, HRT, FDT or SWAP resulted in the highest sensitivities with a limited reduction in specificities (to between 84% and 87%); sensitivity improved to between 73% to 77% when glaucoma was based on disc, and to between 81% and 86% when diagnosis was based on SAP. **Conclusions:** Combining results from structural and functional instruments improves the ability to discriminate between normal and glaucoma eyes.

12.17   **The correlation between change in optic disc neuroretinal rim area and change in differential light sensitivity**
N.G. Strouthidis, D.F. Garway-Heath. Glaucoma Research Unit, Moorfields, London.

Purpose: It has been suggested that the 1/Lambert scale for differential light sensitivity (DLS) may be a more appropriate scale for measurement of visual function than the dB scale. This study examines the relationship between the change in optic disc neuroretinal rim area, and change in DLS, The strength of correlation using decibel scale is compared with 1/Lambert. **Methods:** 11 eyes of 10 patients at risk of glaucomatous progression were examined prospectively over a period of 32-77 months (mean 59 months) with 6-11 examination tests (mean 8.8) at which Heidelberg Retina Tomograph (HRT) images were obtained and Humphrey 24-2 full threshold perimetry was performed. The global and segmental neuroretinal rim area was calculated and expressed as measured/initial rim area. DLS was recorded for the whole visual field and in sectors corresponding to the HRT sectors. The DLS was expressed as measured/initial DLS (for both the dB and 1/Lambert). The proportion of initial neuroretinal rim area was plotted against the proportion of initial DLS and linear regression was performed. **Results:** Significant correlations (p<0.05) were found in 5 eyes between global rim area and dB perimetric change with an average slope of 0.65 (range 0.28-1.29). When DLS was converted to 1/Lambert there was a significant correlation in 4 eyes with an average slope of 2.24 (range 1.09-3.52). The inferotemporal segment had the most significant correlations of the segments – 4 by both scales, with an average slope of 0.41 in the dB scale and 1.34 ib the 1/Lambert scale. **Conclusions:** These results suggest that 1/Lambert scale may overestimate structural change and dB scale underestimates. However there is considerable variability in the slope value. Of the segmental parameters the inferotemporal had a slope closest to 1 in the 1/Lambert scale. The structure/function relationship may vary due to test-retest variability. Also neuroretinal conformational change may result from loss of structures other than ganglion cell axons. Further work on a longer series is needed to determine the optimal scaling of DLS in describing the structural and functional change relationship in glaucoma.

Saturday 29th June

Session Ten: Basic Science II

Moderators: Ted Garway-Heath, London, UK, Kazutaka Kani, Ohtsu, Japan

0845 **Changes in Short-wavelength resolution perimetry with age and defocus in the periphery**

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Background: Resolution acuity for both achromatic and gratings is limited by the responding ganglion cell density in peripheral vision. Achromatic resolution is known to be unaffected by defocus up to 3 diopters. We wished to examine the effect of optical defocus on SWS detection and resolution acuity and how peripheral resolution declined with age for both the achromatic and SWS system. **Methods:**. We measured detection and resolution for SWS-isolating gratings at 0 & 20 degrees eccentricity for optical defocus up to 4 diopters. In addition we measured resolution acuity for both achromatic and SWS-isolating gratings at four 13 degree locations in 50 normal subjects ranging aged 12-70 years. **Results:** Detection acuity declined steadily with defocus but SWS resolution acuity did not decline until 1 diopter in the fovea and 3 diopters at 20 degrees. Resolution acuity was higher for achromatic than SWS-isolating gratings at all ages and neither displayed any decline in performance until around 55 years. After this both declined in a parallel fashion at a rate of 10%/decade. The individual ratio of SWS/achromatic resolution (0.25) showed no correlation with increasing lens density. **Conclusions:** Since resolution for both short-wavelength and achromatic gratings is robust to optical attenuation and declines in a parallel fashion after 55 years there appears to be no selective loss of SWS-driven ganglion cell density relative to achromatic density with age. Support: The Wellcome Trust (UK).

08.57 **Resolution perimetry for blue and achromatic gratings in early glaucoma: implications for selective ganglion cell loss**

R.O. Beirne[1], J. Logan[2], M.B. Zlatkova[1], A.J. Jackson[2], S.J.A. Rankin[2], S. Demirel, R.S. Anderson[1].
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Background: Measurements of achromatic grating resolution acuity in peripheral vision are known to be directly related to the underlying ganglion cell density, and largely unaffected by optical defocus or lens absorption. Recent studies have shown that peripheral resolution acuity for short wavelength sensitive (SWS) isolating gratings is also sampling limited. By measuring resolution acuity for both kinds of stimuli we can directly compare the densities of both achromatic and SWS-driven ganglion cells. **Methods:** Resolution acuity was measured at $13°$ in 4 oblique meridians in 25 eyes (64.9 $\pm$ 9.4 years) with early glaucoma (14 POAG, 4 NTG; MD <-10dB HFA C24-2 program). The results were compared to a group of 23 age-matched normal eyes (62.5 $\pm$ 6.6 years). **Results:** Mean achromatic acuity was significantly lower in the glaucoma patients than normals (2.40 vs. 4.01 cycles/deg; P <0.01). Mean chromatic resolution was also significantly lower in the glaucoma patients than normals (0.66 vs. 0.99 cycles/deg) (P <0.01). The chromatic/achromatic resolution ratio was not statistically different in those with glaucoma compared to the normals (0.27 vs. 0.26). **Conclusions:** These initial results indicate that there is no selective reduction in SWS-driven ganglion cell density in early glaucoma.
Supported by the Wellcome Trust (UK).

09.01 **Detection and Resolution thresholds of high-pass filtered resolution perimetry targets**

Zoran Popovic, Johan Sjöstrand, Department of Ophthalmology, Göteborg University, SE43180 Mölndal, Sweden.

Purpose: Previous studies of high-pass filtered resolution perimetry (HRP) targets have been performed under various luminance and contrast conditions and with different presentation methods, factors which are all known to affect subject performance. The purpose of this study was to evaluate peripheral thresholds for detection and resolution of HRP targets under identical experimental conditions. **Methods:** The targets used were three computer generated high-pass filtered optotypes - tumbling E, Landolt C and the circular Ring perimeter stimulus, and all tests were performed at the same lighting (darkened room), luminance (average 20 cd/m^2) and contrast levels (25%). **Results:** Detection thresholds, similar for all three optotypes, were lower than resolution thresholds at all eccentricities. Landolt C resolution thresholds were greater than tumbling E resolution thresholds at all eccentricities. **Conclusions:** The results support earlier reports of a gap between resolution and detection thresholds in the periphery.

Session Eleven: Basic Science II

Moderators: Ted Garway-Heath, London, UK, Kazutaka Kani, Ohtsu, Japan

09.13   Resolution perimetry using Landolt C

Yakushigawa H., Nishida Y., Miyake T. and Kani K. Department of Ophthalmology, Shiga University of Medical Science, Ohtsu, Japan.

Purpose: We developed a software on Windows 2000 to measure visual acuity at the central field using Landolt Cs. **Methods:** The subjects were requested to look at the center of the fixation target. They answered pushing the key when the test targets were displayed on the random position of the LCD screen in 200 ms and. The examination was conducted according to the method of constant stimuli, where 20 targets of seven different sizes were randomly presented on each test point. Probability of correct answer was plotted and the probability-of-seeing curves were drawn. High and low contrast targets and color targets were used. **Conclusions:** The method was easy and could be used to perimetry in measuring p-system.

09.17   Closing perimetry's sensitivity: a rarebit approach

Lars Frisén, University of Göteborg, Sweden

Purpose: The primary task of clinical perimetry is to identify and grade neurovisual system damage. Clinico-pathologic and experimental studies have highlighted a wanting sensitivity to low to moderate degrees of damage. A possible explanation is that perimetric test targets carry an excess of information, both in space and time. Another possible explanation for poor sensitivity relates to the dependence on external, empirical references for normality: internal references should produce tighter limits. **Methods:** A new visual field test was devised on these premises. The test depended on minimalist test targets, in the form of briefly exposed microdots of high contrast, and the expectation that close to 100% of such targets normally should be visible. A large number of circumscribed test areas were probed repeatedly, with ever-new microdot positions. **Results:** On average, normal subjects responded to 95 ± 3 % of probes. Patients with known visual field defects from a variety of causes missed larger numbers of probes within the defective areas and the deeper the defects, the larger the number of misses. Detailed comparisons where made with high-pass resolution perimetry in 10 patients with minor mid-chiasmal lesions. **Conclusions:** Microdot perimetry revealed nearly twice as extensive defects ($p = .002$), indicating superior sensitivity to low-degree neurovisual damage.

09.21   Oculokinetic Offset Acuity (OKAY) Testing and Early Detection of Pericentral Visual Field Defects

William E. Sponsel, Yolanda Trigo. University of Texas Health Science Center, San Antonio, Texas, USA

Purpose: To utilize oculokinetic, time limited, offset acuity testing to reveal pericentral scotomata undetectable by standard vision screening tests. Microsaccades allow patients with even large perifoveolar and macular defects to 'fill-in' these scotomata and achieve normal vision results on standard acuity or Amsler testing. **Methods:** 21 consenting patients, with and without severs pericentral scotomata by Humphrey threshold perimetry, underwent oculokinetic acuity (OKAy) testing using a moving red-dot fixation target with constant audio feedback. Computer-generated ETDRS letters corresponding to acuities of 20/20, 20/40, 20/50, 20/70, 20/100, and 20/200 were present in each quadrant with the near corner of each optotype 1.5 degree from fixation, for time intervals of 1.0, 0.5, 0.2 and 0.1 sec. Testing proceeded from the largest to smallest optotype size and from the longest to shortest presentation time for each optotype, in randomized quadrant series. **Results:** The study population included 12 age-matched patients with no pericentral defects (8 F: 4 M; mean age 64.3 years) and 9 patients with dense (>20dB depression) pericentral defects (4 F: 5 M; mean age 65.9 years) as demonstrated on HVF analysis. Patients without pericentral defects and best-corrected logMar acuities at 20 ft ranging from 0.4 to 1.0 (mean 0.9 +/- sem 0.1), and those with pericentral defects had logMar acuities ranging from 0.3 to 1.0 (mean 0.7 +/-0.1). There was no statistically significant difference in logMar acuity between the two groups. Good correlation (R=0.9) was noted between the standard time-unlimited distance acuity at 20 ft and OKAy acuities at duration 1.0 or 0.5 sec among all subjects. OKAy testing produced bimodal segregation of patients with pericentral scotomata from those without pericentral defects when offset ETDRS letters were presented for 0.2 or 0.1 sec. The best intratest segregation was obtained comparing OKAy results at 0.5 sec verses 0.1 sec, which produced consistent acuities in normal eyes, but disparate OKAy acuities (in all quadrants) among subjects with pericentral scotomata. **Conclusions:** This study suggests that time limited oculokinetic offset testing at 0.5 sec can rapidly document standard acuity, and when combined with 0.1 sec offset testing can simultaneously detect pericentral visual deficits that elude standard testing strategies. Near or lane-projection OKAy testing may allow for early detection and intervention in patients with

pathology leading to pericentral visual field loss from macular degeneration, diabetic retinopathy and glaucoma.

Session Twelve: Statistical Techniques and Variability II

Moderators: Elliot Werner, Philadelphia, Pennsylvania, USA; Paolo Brusini, Udine, Italy.

09.25 Short-wavelength automated perimetry in normal subjects

Daniel S. Mojon and Mario Zulauf; Department of Strabismus and Neuro-Ophthalmology, Kantonsspital, 9007 St. Gallen, Switzerland.

Purpose: The purpose of this study was to evaluate short-wavelength automated perimetry in normal and glaucoma suspected subjects. The early disappointing results in the normal arm of the study forced us to stop the planned study for ethical reasons. **Methods:** 28 eyes of 28 normal ‚naïve-to-perimetry' subjects (hospital staff, age 21-48 y., mean 36.5 y.) had short-wavelength perimetry (Octopus 101, program G2) after complete eye examination and (normal) white-on-white perimetry (program G2).
Results: In blue-on-yellow perimetry, 21% of the subjects (6/28) were excluded for reliability (reliability factor > 5%). Only 45% of the remaining subjects (10/22) had all indices within normal limits (68% normal Mean Defect, 68% normal Loss Variance, 64% normal Corrected Loss Variance, 86% normal Short-term Fluctuation). **Conclusions:** In highly motivated, but untrained normal subjects, short-wavelength automated perimetry with Octopus G2 program rendered a specificity of 55% when visual fields are considered to be normal if all indices are within normal limits. The current normal range of the indices should be reevaluated in order to achieve a higher specificity.

09.29 Localized field loss influences the estimation of diffuse loss more in SWAP than in white-on-white perimetry

Peter Åsman[1] and John M Wild[2]. 1) Dept of Ophthalmology, Malmö University Hospital, Malmö, Sweden, 2) Dept of Optometry and Vision Sciences, Cardiff University, Cardiff, Wales, UK.

Purpose: To evaluate differences between white-on-white perimetry (WW) and SWAP in terms of their susceptibility errors in the estimation of diffuse loss induced by non-uniform field loss. **Methods:** One Humphrey 30-2 Full Threshold test obtained with each of WW and SWAP were obtained in 49 normal individuals with previous experience with both perimetric methods. Non-uniform field loss was modelled by randomly selecting stimulus locations to be changed by −10 dB. Ten such models were constructed for each possible number of points (1 to 74) yielding 740 models of field loss. Each of the 740 models were superimposed on each of the actually measured fields. The Statpac General Height (GH) was determined before and after the superimposition and the induced errors in GH were compared between WW and SWAP. **Results:** Increasing number of points involved in the superimposed field loss yielded increaing errors of GH in WW as well as in SWAP. The induced error was larger for SWAP than for WW being negligible whith small superimposed loss (0.08dB for SWAP and 0.07dB for WW with 1-10 chenged locations) but increased with increasing localized loss (1.0 dB for SWAP vs 0.7dB with 30-40 changed locations; 1.7 vs 1.1 dB with 40-50 locations; 2.7 vs 1.8 dB with 50-60 location). **Conclusions:** Loaclized field loss leads to overestimation of diffuse field loss. The overestimation increases with increasing spatial extent of localized field loss and is generally larger with SWAP than with WW. These results have direct implications for the construction of statistical analysis packages for SWAP.

09.41 Utility of dynamic termination criteria in Bayesian adaptive threshold procedures

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Purpose: Bayesian adaptive threshold procedures, such as SITA [*Acta Ophthalmol Scand*, 1997, 75, 368-375], may be run for a fixed number of trials, or may be stopped when the calculated confidence interval for the threshold reaches a nominated limit (a *dynamic termination criterion*). This study examined whether a dynamic termination criterion has any advantage over a fixed trial procedure. **Methods:** Monte-Carlo techniques simulated the performance of both fixed trial and dynamically terminated yes/no psychophysical procedures. The slope of the simulated observer's psychometric function and the false positive response probability were systematically varied. **Results:** No difference was found between the distribution of errors in a fixed trial procedure versus a dynamically terminated procedure of the same

average number of trials. In addition, the width of the confidence interval failed to usefully predict observer variability arising from either a shallow psychometric function slope or an increased false positive response probability. **Conclusions:** This study suggests that dynamic termination criteria are of little use in Bayesian adaptive threshold procedures.

09.53 FDT staging system accuracy in classifying glaucomatous damage severity

Paolo Brusini and Claudia Tosoni. Department of Ophthalmology – Santa Maria della Misericordia Hospital, Udine, Italy

Purpose: To study the accuracy of the FDT Staging System, which uses MD and PSD values, in staging the severity of glaucomatous damage. **Methods:** 76 eyes with chronic open-angle glaucoma were studied with standard automated perimetry and FDT (N-30 theshold test). Structural damage was assessed both with optic disk stereoscopic examination and with the GDx. Patients were subdivided into three groups (early, moderate, and advanced damage) according to a clinical classification. Then we measured the ability of FDT Staging System in classifying the glaucomatous damage severity. **Results:** a statistically significant correlation was found between the FDT Staging System classification and the clinical classification of severity stage. **Conclusions:** the FDT Staging System is able to stage the damage severity in glaucoma and can also supply useful information on the type of defect.

09.57 Development of cumulative defect (Bebie) curves for frequency doubling technology (FDT) perimetry

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Purpose: Cumulative defect curves have been employed in conventional automated perimetry to permit the subjective classification of diffuse and localized visual field loss. The purpose of this investigation was to determine whether a similar procedure could be developed for Frequency Doubling Technology (FDT) perimetry. **Methods:** FDT results from 407 normal subjects between the ages of 18 and 85 were used to construct cumulative defect (Bebié) curves. After adjusting for the effects of normal aging (normalizing to an "average" 45 year old), total deviation values (deviation from the average normal sensitivity) was determined for the 19 stimulus locations of the N-30 Full Threshold program. The total deviation values were then rank-ordered from the best (most plus, least minus) to worst (least plus, most minus) values and the 5th, 50th and 95th percentiles were determined. **Results:** FDT cumulative defect (Bebié) curves for FDT are remarkably similar in form to those derived for conventional automated perimetry. Clinical examples will be presented to illustrate how these curves can be employed to characterize normal, diffuse, localized and mixed visual field properties for FDT.
Conclusions: Cumulative defect (Bebié) curves for FDT are a useful means of distinguishing diffuse from localized visual field loss.

Session Thirteen: Screening

Moderators: Evanne Casson, Ottawa, Canada; Mario Zulauf, St. Gallen, Switzerland.

10.50 Screening versus threshold FDT test in early glaucomatous damage detection

Paolo Brusini, Claudia Tosoni and Lucia Parisi. Department of Ophthalmology – Santa Maria della Misericordia Hospital, Udine, Italy.

Purpose: to compare the sensitivity and specificity of the Frequency Doubling Technology (FDT) C-20 screening test in early glaucoma with the same test performed with threshold strategy. **Methods:** 35 eyes from 35 patients with early open-angle glaucoma were studied with FDT, using both the screening and threshold C-20 test. The specificity rate of these two tests was evaluated testing 24 normal subjects.
Results: the sensitivity rate of FDT screening test ranged from 82.9% to 91.4, depending on the abnormality criteria used. The FDT threshold strategy gave only slightly better results. In the control sample, the specificity rate ranged from 91.7% to 100% using the screening strategy, and from 66.7% to 87,5% using the threshold test. **Conclusions:** in early glaucoma both the FDT screening and threshold C-20 test gave a satisfactory sensitivity and specificity.

11.02 **Screening for Glaucoma with the Non Mydriatic Fundus Camera (NMFu-Camera) and the Frequency Doubled Perimeter (FDP)**

T. Zeyen (University Hospital, Leuven, Belgium), M. Detry (St. Luc University Hospital, Université Catholique de Louvain, Brussels, Belgium), P. Kestelyn (University Hospital, Gent, Belgium), J. Collignon (University Hospital, Liège, Belgium), M. Goethals (University Hospital, Leuven, Belgium) and the Belgian Glaucoma Society.

Purpose: To evaluate the usefulness of the NMFU-camera and the FDP for detecting glaucoma in a general population. **Methods:** The population of 3 Belgian cities was invited by advertisement in newspapers and TV to present for glaucoma screening. The IOP was measured with the non-contact pneumo-tonometer (NCT) followed by applanation tonometry (AT) if the NCT-IOP was ≥ 17 mmHg. The visual field screened with the FDP (C-20-5) and optic disc photographs were taken with he NMFU-camera (Canon CR6-45NM). FDP was considered abnormal if at least one defective point was found. The optic disc photographs (ODP's) were graded as normal or glaucomatous by consensus of three glaucoma specialists. Treated patients were excluded from the analysis. **Results:** 1800 subjects were examined and 1684 included in the study. The mean age was 63.5 ± 10.8 years. Six per cent (6%) had an AT-IOP measurement > 21 mmHg. 97.6% of the ODP's could be interpreted. Glaucomatous optic discs were detected in 3.7% of the subjects. FDP was abnormal in one eye in 19% and in both eyes in 23% of the subjects. The sensitivity and specificity of FDP in detecting he eyes with glaucomatous optic discs were 57% and 69% respectively. **Conclusions:** the non-mydriatic fundus camera is a useful method to screen for glaucoma. FDP in screening strategy is not sensitive enough when the cut-off value is set at one defective test location.

11.14 **A new screening program for flicker perimetry**

C. Matsumoto, S. Okuyama, S. Takada, E. Arimura, S. Hashimoto, Y. Shimomura. Department of Ophthalmology, Kinki University School of Medicine, Osaka-Sayama, Japan

Purpose: We developed a new screening program for automated flicker perimetry in order to shorten the test duration and to reduce the task of the patients. In this study, we evaluated the clinical usefulness of the new screening program in normal subjects and glaucoma patients. **Methods:** Forty eyes of 40 normal subjects and 49 eyes of 49 glaucoma patients were examined by light-sense perimetry, frequency doubling perimetry and flicker perimetry. Flicker perimetry was performed using the Octopus 1-2-3 and its remote software package with a new screening program No. 38S. The screening program used a four-category, three-level suprathreshold strategy, which we called a 4-zone 'probability' strategy. The screening levels were set at 5%, 1% of probability of normality and 5 Hz. Frequency doubling perimetry was performed using screening program C-20. Light-sense perimetry was performed using HFAII full threshold program 24-2. **Results:** The average test duration with the screening program No. 38S was about 3 minutes in normal eyes and about 5.5 minutes in glaucoma patients. The sensitivity of screening program No.38S was 97% in all the glaucoma patients (90% in early stages and 100 % in moderate and advanced stages). The sensitivity of the FDT program C-20 was 94% in all patients (90% in early stages and 97 % in moderate and advanced stages). The specificity of program 38S was 100% in normal subjects. **Conclusions:** The 4-zone 'probability' strategy is a timesaving and practical method for screening flicker field defects.

Session Fourteen New Techniques 3

Moderators: Enrico Gandolfo, Brescia, Italy; Sheban Demirel, Portland Oregan, USA.

14.00 **Assessment of reaction times in order to enhance quality of semi-automated kinetic perimetry (SKP) - an age-related normative study**

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Purpose: To define age-related, normal values of reaction time (RT) in semi-automated kinetic perimetry (SKP) under various stimulus conditions , considering also quality control parameters. **Methods:** The study protocol is set for 84 ophthalmologically and generally healthy subjects between 10 and 79 years of age. Four different types of stimuli were presented (Goldmann-Standard): III 4e at 5°/s, III 4e at 25°/s, I 3e at 5°/s and I 2e at 2°/s, respectively. Background luminance was set to 10 cd/m². For each stimulus condition, two stimuli were presented within the central visual field region in order to assess individual RT: one along the nasal horizontal meridian, the other one along the temporal oblique meridian (right eye

– 45°; left eye – 135°). Each stimulus was presented six times in random order. In this study, the geometric means of the RTs for the age groups 10-19 y. and 60-69 y. are considered. Additionally, 8 sub-threshold stimuli (Goldmann I 1a) were presented in the extreme periphery in order to test for false-positive answers. **Results:** The mean of reaction times measured with stimulus III4e 5 °/s was 0.61s (<u>coefficient</u> of <u>variation</u> [CV] 26%) in the younger group, and 0.57s (CV 25%) in the older subjects. There was a considerable inter-individual variability (21%). In almost all stimulus and for both age groups, the RTs related to targets moving along the oblique (0.65s) meridian were significantly longer than those related to stimuli moving along the horizontal (0.57s) meridian (group 10-19y.; stimulus III 4e at 5°/s, p<0.001); 9% of all sub-threshold stimuli produced false positive answers. RT was $\geq 0.2s$ in 85% (MEAN 0.65s, SD 0.32s) of these cases. **Conclusions**: It is important to assess *individual* reaction times because of considerable interindividual variability even in this group of normals. Direction of stimulus movement should be considered. As false positive answers in kinetic perimetry are predominantly linked to RTs "within the normal range", catch trials should not be replaced by scoring only very low RTs as false positive answers.

14.12 Realisation of semi-automated kinetic perimetry (SKP) with the Interzeag 101 instrument

Ulrich Schiefer, Stephan Rauscher, Jens Paetzold, Jan Schiller. University Eye Hospital Tuebingen, Dept. II, FRG

Purpose: Kinetic perimetry is the method of choice in cases of advanced visual field loss (e.g. altitudinal defects, quadrantanopia, hemianopia or concentric constriction), in patients with impaired co-operability, and in examinations dealing with expert opinion or other topics of socio-ophthalmological relevance. However, examinations with the conventional Goldmann perimeter are considerably impaired by examiner-related shortcomings, like unintended variation in stimulus velocity, reduced spatial resolution within the central (15°) visual field, insufficient consideration of patients´ reaction times and response variability. By the help of a re-designed mirror unit and a completely revised user interface, which can be integrated into all OCTOPUS 101 perimeters, a smooth, constant stimulus motion with angular velocities up to 80°/s in any direction within the entire 90° cupola area is realised. The examiner can choose any arbitrary origin, direction and length of a so-called "vector", along which the pre-defined stimulus is moved by the computer program with a selected constant angular velocity. Stimulus presentation is stopped by response of the patient. This procedure can be repeated in order to estimate the scatter ($\rightarrow$ standard deviation = SD) of average local responses ($\rightarrow$ MEAN). Presentations within intact visual field areas are used in order to assess and optionally correct for patients´ individual reaction time characteristics (for further details, see *S. Rauscher et al., IPS 2002*). **Methods:** Age-correlated normative data (Goldmann stimulus III 4e) were obtained in 12 patients per each decade with an angular velocity of 5°/s, using six centripetal stimulus presentations in random order along each of the eight cardinal meridians. **Results:** Along the nasal horizontal meridian the "kinetic thresholds (eccentricities)" are 53.7° ± 6.8° (MEAN ± SD), and 54.4° ± 8.0°, for the second and seventh age decade, respectively. Considering individual reaction times, these values increase to 56.8° ± 6.5°, and 57.3° ± 7.9°, respectively. **Conclusions:** A special teaching option of the program with built-in "artificial scotomata" yields training and quality control of SKP in unexperienced examiners and should remarkably steepen the learning curve in case of expert supervision.

14.24 A computer application for training kinetic perimetry

J. Pätzold, J. Schiller, S. Rauscher, U.Schiefer. Department of Neuro-Ophthalmology, University Eye Hospital, Tuebingen, Germany

Purpose: Kinetic perimetry (e.g. with the Goldman perimeter) is still the examination of choice for extended visual field loss and expert opinion. Unfortunately, nowadays only certain centres are able to conduct this kind of examination and as a result experienced examiners are becoming more and more rare. For this reason a training program for kinetic perimetry has been developed, which is based on the user interface for "Semi-automated Kinetic Perimetry" (SKP; see *Schiefer et al., IPS 2002*) used with the OCTOPUS 101 [INTERZEAG]. **Methods:** Different kinds of scotomata can be selected for the simulation (e.g. quadrantanopia / hemianopia, glaucomatous visual field defects). The simulations are based on normal values obtained at the OCTOPUS 101 perimeter with kinetic stimuli and are modified at the locations of the "virtual" visual field defect corresponding to the underlying pathology assumed. **Results:** As it is in reality, in the flatter parts of the "hill of vision" the scatter of the stimulus answer positions is wider than in a steeper region. To simulate the patient response individual reaction times for each stimulus are calculated with a realistic distribution imitating the natural scatter (see *Rauscher et al., IPS 2002*). **Conclusions:** As a result this training software offers the opportunity to increase the skills and experience of examiners in kinetic perimetry. In the nearer future an additional option will allow to create any arbitrary virtual visual field defect to train a wider field of possible scotomata.

14.29   Evaluation of stato-kinetic dissociation using (examiner-independent) automated perimetric techniques.

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Purpose: To evaluate stato-kinetic dissociation using (examiner-independent) automated perimetric techniques. **Methods:** Fifteen patients with advanced, stable visual field defects of different origins (retinitis pigmentosa, glaucoma, and lesions of the posterior pathway) were evaluated with kinetic and static perimetric methods. In an initial session the border of the scotoma was roughly estimated with manual kinetic and static perimetry (26' stimulus; luminance 110 cd/m²; background luminance 10 cd/m²). **Results:** Based on these results two individually adjusted perimetric sets of vectors were defined – one for the static and one for the kinetic automated examination. Each kinetic set of vectors consisted of 16 to 24 vectors (length 6° each), which started approximately 2 to 3° within the scotoma and crossed the scotoma border almost perpendicularly. In the kinetic mode 4 to 8 additional vectors were presented in healthy parts of the visual field to estimate the individual reaction time of the patient. Stimulus characteristics: size 26', luminance 110 cd/m²; kinetic mode: 2°/sec.; each stimulus was presented six times in a randomised order as well in the kinetic as in the static mode. The static set of vectors consisted of the same number of vectors as the kinetic set and had (almost) the same localization. Where manual examination revealed (local) stato-kinetic dissociation the localization of the vectors was modified. Each static vector consisted of 5 test point localizations on it (inter-stimulus distance 1.5°). All examinations were carried out with the Tuebingen Computer Campimeter (TCC). Stato-kinetic dissociation (SKD) was defined as positive, if the static scotoma was larger as the kinetic, otherwise as negative. **Conclusions:** The maximum local positive SKD was 13.5°. Eight patients showed a local negative SKD (maximum 1.2°). Both methods revealed considerable inter- and intraindividual fluctuations along the scotoma border.

Session Fifteen: Statistical Techniques and Variability III

Moderators: Anders Heijl, Malmo, Sweden; Pam Sample, San Diego, California, USA.

15.10   Mixture of factor analysis of standard visual fields

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Purpose: To extract patterns of field loss using Variational Bayesian Mixture of Factor Analysis (vbMFA). **Methods:** Standard perimetry absolute threshold values for 52 locations plus age from one eye each of 156 patients diagnosed with glaucomatous optic neuropathy (GON) and 189 normals were evaluated with unsupervised vbMFA to separate the fields into clusters. Fields were not used to select subjects. **Results:** The vbMFA formed 4 distinct clusters. The "normal cluster" held 186 normals + 45 patients. Each GON cluster could be represented by a"typical" pattern of defect: GON1 (56 patients + 3 normals) by a general reduction with MD of −2.65 ± 1.72; GON 2 (39 patients) by a superior hemifield defect, and GON 3 (16 patients) by an inferior hemifield defect with or without superior field involvement. Specificity was 98%; sensitivity was 71%. **Conclusions:** vbMFA accurately clustered patients into groups with typical glaucomatous patterns of loss. vbMFA may be very helpful for learning patterns of defect in newer tests psychophysical tests having different numbers and locations for test stimuli.

15.22   Comparison of different methods for detecting glaucomatous visual field progression

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Purpose: To compare the performance characteristics of 7 criteria for analyzing glaucomatous visual field progression. **Methods:** Initial and final Humphrey 30-2 visual fields (separated by 7 years) of 76 patients with open-angle glaucoma were entered into a computer simulation program, which generated 14 interim semi-annual fields under conditions of high, moderate and no variability. Progression was analyzed using the methods of AGIS, CIGTS, 3 criteria based on a Glaucoma Change Probability-like (GCP-like) analysis, and 2 criteria based on pointwise linear regression analysis (PLRA). Specificities were calculated by using the same visual field of each patient as both the initial and final field (no progression) under conditions of moderate and high variability. **Results:** For moderate variability, all criteria that were studied had high specificity (92% or higher). The AGIS, CIGTS, PLRA and one of the GCP-like determinations were relatively robust in their specificity under high variability conditions. With no variability,

progression rates were 18% for AGIS, 36% for CIGTS, 47% to 62% for the 3 GCP-like criteria, and 67% to 72% for the 2 PLRA criteria. Progression rates increased with greater variability for the 3 GCP-like criteria, and decreased for all other criteria. The time to detect confirmed progression was longest for the 2 PLRA criteria and shortest for the CIGTS and GCP-like criteria. **Conclusions:** AGIS and CIGTS criteria had high specificity, but classified fewer cases of progression than the other criteria. GCP-like criteria had the shortest follow-up times to confirmed progression, but were not as specific. Criteria based on PLRA were specific but follow-up times to confirmed progression were the longest.

15.34 Effects of pupil dilation and stimulus size on 10-2 visual fields in advanced glaucoma

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Purpose: To estimate the effects of pupil dilation and stimulus size on macular perimetry in patients with advanced glaucoma. **Methods:** 12 patients with stable advanced glaucoma were tested using the full threshold, HFA program 10-2. One eye (n=12) was tested with natural pupils, with size V and size III. One eye (n=10) was tested with size III with and without dilation of the pupil. All tests were repeated twice within one week. Statistical comparisons were for dependent means across all seen points, and for independent means across two subsets of points: "high sensitivity" (sensitivity to size III from 25.0 –35.0 dB) and "low sensitivity" (5.0–24.5 dB). **Results:** Sensitivity was slightly higher for natural pupils (mean ± 1 SE = 1.1 ± 0.2 dB; t=5.1, p<0.0005), and dramatically higher for stimulus size V (7.2 ± 0.3 dB; t=21.6, p<0.0005). Effect of dilation was similar for both high sensitivity and low sensitivity subsets (t=0.82, p=0.41), but effect of stimulus size was greater for the low sensitivity subset (8.8 ± 0.5 dB vs. 3.9 ± 0.4 dB; t=8.09, p<0.0005). Test-retest variability was reduced 1.5-fold both by dilation and by increase in stimulus size (t>3.6, p<0.0005). For the high sensitivity subset, test-retest variability was not affected by dilation (t=0.15, p=0.88) or stimulus size (t=1.91, p=0.06). For the low sensitivity subset, test-retest variability was reduced 1.6-fold by dilation and 3.5-fold by increase in stimulus size (t >5.6, p<0.0005). The size effects are similar to previous reports for defects at more eccentric locations. **Conclusions:** In macular perimetry of patients with advanced glaucoma, effects of both pupillary dilation and stimulus size should be considered.

15.38 Variability components of standard perimetry

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Purpose: To examine the temporal behaviour of threshold and response variability. **Methods:** 8 trained normal individuals and 7 glaucoma patients were examined using standard perimetry. The method of constant stimuli was used with to test three test locations in a single eye of each subject using an externally controlled Humphrey Field Analyzer I. Subjects were tested once weekly for five consecutive weeks. Frequency-of-seeing curves were constructed by fitting data with cumulative Gaussian functions and were used to define threshold (50% detection level, dB) and response variability (inter-quartile range, dB). The distribution of these parameters over the study period was used to quantify their temporal behaviour. **Results:** Response variability was higher (shallower frequency-of-seeing curve slope) in glaucoma patients than normal individuals (p=<0.001). Additionally, variation in both threshold sensitivity and frequency-of-seeing curve slope were demonstrated and were significantly greater in glaucoma patients than normal individuals. Both these variability components were inversely related to mean threshold sensitivity. Change in threshold sensitivity and frequency-of-seeing curve slope for test locations tested within an individual did not occur in parallel for the majority of subjects. **Conclusions:** Previous reports have demonstrated that the frequency-of-seeing curve becomes less steep with glaucomatous sensitivity loss. This study has shown that within an individual, in addition to shallow gradient, sensitivity loss is also accompanied by increased variability of curve slope and curve position in sensitivity space. However, specified changes in slope or sensitivity at one test location in an individual's visual field between successive tests did not imply that similar magnitude or direction of change was occurring at other test locations.

15.50 Interpolation of perimetric test grids using neural networks

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Purpose: To interpolate the test grid of the Tuebingen Automated Perimeter TAP using neural networks. **Methods:** TAP uses a threshold-oriented slightly supra-liminal strategy, resulting in a high test point density with centripetal condensation (191 test locations within the central 30° visual field). Defect depth is scored by 6 luminance classes. In this study we used a dataset of 702 perimetric records. We designed a feed-forward neural network with the test point coordinates as input data and the corresponding luminance classes as output data. For training we used a subset of $191-n$ test points and in a second step we tested the interpolation capability with the remaining n test points, with $n = 19; 38; 47$. **Results:** Correctly predicted luminance classes ranged from 83% for 19 to 73% for 47 unknown test points. **Conclusions:** Artificial Neural Networks are able to interpolate perimetric test grids, this is an essential pre-requisite for individually generated grid-independent examination procedures.