Purpose: The full contrast sensitivity function (CSF) describes different aspects of visual performance including: peak contrast sensitivity (CS) – 1/contrast threshold assessed at medium-to-large optotype sizes – and contrast acuity (CA) – optotype size thresholds assessed at high-contrast. CS testing has had limited use as a visual outcome, due to imprecision in the clinical setting. The purpose of this study was to (i) evaluate CS differences in normal and impaired vision, as assessed with the novel qCSF tester (Adaptive Sensory Technology), (ii) to evaluate and compare repeatability of CS testing in normal and impaired vision.

Methods: qCSF data was obtained in 40 eyes (20 normal subjects) and 60 eyes (30 glaucoma subjects) with an average visual field (VF) loss of -9.5 (SD=8.6) dB assessed by Humphrey 24-2. CS data was collected in monocular conditions, with worse-seeing eye retested for glaucoma subjects and both eyes retested for normal subjects. Re-test measurements were obtained to assess repeatability and precision.

Results: In normal subjects AULCSF (mean=1.58;SD=.15), and CA (mean=1.40;SD=.09) values were consistently higher and less variable than those observed in glaucoma: AULCSF (mean=.88;SD=.47), and CA (mean=1.02;SD=.33). The coefficients of repeatability for AULCSF and CA were .15 and .13 decimal log units for normal vision and .11 and .12 log units for glaucoma, respectively. The area under the Receiver Operating Characteristic (ROC) for discriminating eyes with normal and impaired vision was 93% for AULCSF and 91% for CA.

Conclusions: This study demonstrates that qCSF yields better contrast sensitivity in normal eyes, compared to glaucomatous eyes. Of note, repeatability is comparable in both groups, for both AULCSF and CS metrics. The qCSF exhibits potential as a clinical trial endpoint, as contrast sensitivity has been previously shown to affect visual quality of life.
Bland-Altman plots presenting AULCSF and CA test-retest scores, and coefficients of repeatability (COR) for normal (blue) and glaucomatous (red) eyes.

**Commercial Relationships:** Simrat K. Sodhi, None; Saghar Bagheri, None; Yulia Wolfson, None; Pradeep Y. Ramulu, None; Pujan Dave, None; Luis A. Lesmes, Adaptive Sensory Technology, US7938538/WO2013170091 (P), Adaptive Sensory Technology (I); Emma McDonnell, Rupert W. Strauss, None; David S. Friedman, None; Hendrik P. Scholl, None

**Support:** Clark Foundation

**Program Number:** 618 **Poster Board Number:** B0117 **Presentation Time:** 1:30 PM–3:15 PM

**Evaluation of contrast sensitivity function in individuals with Fabry disease**

**Pinakin G. Davey, Kaydee McCray.** College of Optometry, Western University of Health Sciences, Pomona, CA.

**Purpose:** Fabry disease is a rare genetic lysosomal storage disorder (1 in 117,000 people) that leads to progressive accumulation of globotriaosylceramide deposits in a variety of cells including cornea which leads to development of cornea verticillata. Not all individuals show a visible deposit and cornea verticillata but have intracellular deposits when examined under a corneal confocal microscope. We sought to investigate if individuals with Fabry disease have decreased contrast sensitivity function when compared to ocular healthy adults.

**Methods:** A total of sixty seven individuals were included in the study (32 Fabry and 35 healthy controls). The measurements of distance and near visual acuity, slit lamp examination, anterior and posterior segment photography and optical coherence tomography measurements (both macula and optic nerve) were obtained. Individuals also underwent binocular contrast sensitivity function (CSF) measurement with a portable near Quick CSF (Adaptive Sensory Technology, Boston MA) which uses Bayesian inference and a trial-to-trial information gain strategy to obtain rapid measurements of contrast sensitivity. The CSF was measured with 50 trials and estimates of area under the log CSF (AULCSF), high spatial frequency cutoff (CSF acuity), and contrast sensitivity at 1, 1.5, 3, 6, 12 and 18 cycles per degree (cpd) were obtained.

**Results:** The mean age and standard deviation of ocular healthy group and Fabry group was 36.22 SD 6.4 and 37.83 SD 10.6. The mean age and logmar visual acuity distance and near were not significantly different between the groups (Independent samples t-test p=0.54, 0.07 and 0.08 respectively). The CSF values did not follow a normal distribution (Kolmogorov-Smirnov test p=0.05). The CSF function at all spatial frequencies were lower in Fabry group compared to the ocular healthy group. The AULCSF and CS at 1, 1.5, 3 and 6 CPD were significantly lower in the Fabry group compared to the ocular healthy group (Mann-Whitney p<0.05). The CSF acuity and CS at 12 and 18 CPD were not significantly different between the groups (Mann-Whitney p>0.05) (see Figure 1)

**Conclusions:** The mean CSF at the low and the mid spatial frequencies region is lower in Fabry group compared to the healthy group whereas CSF in high spatial frequencies region and visual acuity are not significantly different. This may in part be responsible for the vision related issues reported by patients with Fabry disease.

**Figure 1**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Fabry group</th>
<th>Healthy group</th>
</tr>
</thead>
<tbody>
<tr>
<td>AULCSF²</td>
<td>2.12 ± 0.23</td>
<td>2.23 ± 0.23</td>
</tr>
<tr>
<td>CS at 1 cpd²</td>
<td>1.44 ± 0.11</td>
<td>1.47 ± 0.10</td>
</tr>
<tr>
<td>CS at 1 cpd³</td>
<td>1.78 ± 0.15</td>
<td>1.83 ± 0.13</td>
</tr>
<tr>
<td>CS at 1 cpd⁴</td>
<td>2.02 ± 0.15</td>
<td>2.07 ± 0.12</td>
</tr>
<tr>
<td>CS at 1 cpd⁵</td>
<td>1.40 ± 0.16</td>
<td>1.47 ± 0.13</td>
</tr>
<tr>
<td>CS at 1 cpd⁶</td>
<td>1.57 ± 0.22</td>
<td>1.64 ± 0.29</td>
</tr>
<tr>
<td>CS at 1 cpd⁷</td>
<td>1.04 ± 0.20</td>
<td>1.13 ± 0.26</td>
</tr>
<tr>
<td>CS at 1 cpd⁸</td>
<td>0.41 ± 0.35</td>
<td>0.72 ± 0.31</td>
</tr>
</tbody>
</table>

Where

AULCSF is area under log contrast sensitivity function.

CS acuity is high spatial frequency cutoff.

CS is contrast sensitivity.

* Represents parameters that were significant at p<0.05 Mann Whitney U test

**Commercial Relationships:** Pinakin G. Davey; Kaydee McCray, None

**Support:** National Fabry Disease Foundation

**Program Number:** 619 **Poster Board Number:** B0118 **Presentation Time:** 1:30 PM–3:15 PM

**Two-color pupillometry in enhanced S-cone syndrome**

**Frederick T. Collison¹, Jason C. Park², Gerald A. Fishman¹, ², Jason M. Anany².** ¹The Pangere Center for Inherited Retinal Diseases, The Chicago Lighthouse, Chicago, IL; ²Department of Ophthalmology and Visual Sciences, University of Illinois at Chicago, Chicago, IL.

**Purpose:** The purpose of this study was to evaluate pupillary light reflexes (PLRs) mediated by rod, cone, and intrinsically photosensitive retinal ganglion cell pathways as indices of outer- and inner-retinal function in enhanced S-cone syndrome (ESCS) patients.

**Methods:** Four patients with ESCS (ages 16-23 years) participated in the study. Subjects were tested with long- and short-wavelength single-flash ERG stimuli under light adapted conditions. They were also tested with an established pupillometry protocol involving 1-second duration, full-field, long- and short-wavelength stimuli. The PLR was measured as a function of stimulus luminance (4 log cd/m² to 2.6 log cd/m² under dark-adapted conditions and -1 log cd/m² to 2.6 log cd/m² under light-adapted conditions). Transient relative pupillary responses were measured under all conditions, and a sustained pupillary response was measured under the highest luminance dark-adapted condition.

**Results:** Two-color light-adapted full-field ERGs demonstrated larger amplitude responses for short-wavelength stimuli relative to long-wavelength stimuli, with 3 of 4 ESCS patients having super-normal a-wave amplitudes to the short-wavelength stimulus. B/A wave ratios were reduced in all four cases. Transient PLRs elicited by low luminance stimuli under dark-adapted conditions (rod-mediated) were unrecordable, whereas the sustained PLRs elicited by high luminance stimuli (melanopsin-mediated) were normal. Cone-mediated PLRs were recordable for all four patients, but generally reduced in amplitude. However, the cone-mediated PLR was larger for the short-wavelength stimulus compared to the photopically matched long-wavelength stimulus at high luminances, a pattern that was not observed for control subjects. None of the PLR conditions demonstrated “super-normal” findings.

**Conclusions:** ESCS patients appear to have generally well-preserved cone- and melanopsin-mediated PLRs, indicating intact inner-retinal function. Two-color pupillometry demonstrates greater sensitivity
to short-wavelength light under higher-luminance conditions and could complement the ERG as a tool for evaluating retinal function in EPCS.

**Commercial Relationships:** Frederick T. Collison, None; Jason C. Park, None; Gerald A. Fishman, None; J Jason McAnany, None

**Support:** The Pangere Family Foundation, Gary, Indiana (GAF); National Institutes of Health Research grants EY019510 (JM) and EY001792 (UIC core grant) and an unrestricted departmental grant from Research to Prevent Blindness.

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**Program Number:** 620 Poster Board Number: B0119  
**Presentation Time:** 1:30 PM–3:15 PM  
**Altered Adaptation of the Pupillary Light Reflex and Sleep Irregularity in Photophobic Individuals with TBI**  
*Phillip T. Yuhas, Patrick Shorter, Catherine McDaniel, Michael Earley, Andrew Hartwick.* The Ohio State University College of Optometry, Columbus, OH.

**Purpose:** The pathophysiology underlying the photophobia and sleep irregularities experienced by many individuals after traumatic brain injury (TBI) is poorly understood. We hypothesize that mechanical disruption of ganglion cell photoreceptor function is responsible. The goal of this work is to examine whether adaptive pupil responses and sleep patterns are altered in photophobic individuals with mild TBI.

**Methods:** 28 case subjects with prior TBI and photophobia were recruited, with 24 (age 43.3±2.3; 50% F) meeting eligibility criteria after comprehensive eye examinations. Over 2 study visits, they were administered a sleep log, actimeter, and a series of 2 min-long pupil tests on the RAPDx pupillometer using alternating red/blue flashing (0.1 Hz for 2 min) light stimuli: This pupil test was performed in 3 ways, with the light applied: 1) OU (undilated), no dark adaptation (0-DA test); 2) OU (undilated), 5 min dark adaptation (5-DA test); 3) OS (dilated), 30 min dark adaptation (30-DA test). 12 healthy subjects (age 42.6±4.4; 58% F) were controls. The enhancement of pupil constriction during pupil testing and sleep quality markers (including duration, onset latency, and efficiency) were calculated.

**Results:** In the 0-DA test, normalized pupil constriction during the last two pulses of red/blue light was significantly greater than during the first two pulses (difference of 9.26±1.3; p<0.05) in cases but not controls (difference of 4.04±1.7; p>0.05). No significant differences (p>0.05) in pupil constriction between the first two pulses of red/blue and the final two pulses were evoked by either the 5-DA and 30-DA tests on cases and controls. Sleep onset latency was significantly (p<0.05) greater in cases (33.4±4.6 min) than controls (17.1±3.2 min). No significant differences (p>0.05) were found between cases and controls for sleep duration or efficiency; however, a trend toward correlation between magnitude of pupil enhancement and variance in duration was detected in cases (r=0.39; p=0.06).

**Conclusions:** Cases had longer sleep onset latency and more pupil constriction enhancement than controls. Specifically, in case subjects the pupil responses to alternating red/blue light stimuli were significantly altered when the test was administered without prior dark adaptation. This pupil testing strategy has potential as an objective assessment of neuronal function in photophobic TBI patients.

**Commercial Relationships:** Phillip T. Yuhas, None; Patrick Shorter, None; Catherine McDaniel, None; Michael Earley, None; Andrew Hartwick, None

**Support:** Department of Defense TATRC Grant W81XWH-12-1-0434  
**Clinical Trial:** NCT01942564

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**Program Number:** 621 Poster Board Number: B0120  
**Presentation Time:** 1:30 PM–3:15 PM  
**Characterisation of Scotopic Vision in Patients with Choroideremia Utilising full-field stimulus threshold (FST)**  
*Jasleen K. Jolly1, 2, Charles L. Cottriall1, Markus Groppe1, Robert E. MacLaren1, 3.* 1Nuffield Department of Clinical Neurosciences, University of Oxford, Oxford, United Kingdom; 2Optometry Department, Oxford Eye Hospital, Oxford, United Kingdom; 3Oxford Eye Hospital, Oxford, United Kingdom.

**Purpose:** Loss of night vision is an early symptom of choroideremia and other retinal degenerations that primarily affects the rod photoreceptor. The full-field stimulus threshold (FST) is an established measure of absolute scotopic thresholds (in dB) and is a summed response across the retina. FST was therefore used to assess scotopic thresholds in a large cohort of patients with choroideremia.

**Methods:** FST measurements were made using the Espion 2 (Diagnostics LLC, Cambridge, UK). In order to characterise scotopic function in choroideremia, patients (n=56) attending screening appointments for the gene therapy trial (NCT01461213) underwent FST testing, following 45 minutes dark adaptation. Additionally a cohort of normal age-matched controls (n=34) and female choroideremia carriers (n=10) were also assessed with FST. All comparative statistics were conducted on the right eye only (tested first).

**Results:** The FST threshold values (mean ± SEM) in the patient group were -21.2 ± 2.0 dB, choroideremia carrier group -43.9 ± 2.4 dB, and control group -51.8 ± 0.7 dB. All three groups were significantly different to each other (Kruskal-Wallis ANOVA, p<0.0001 for all points). Males and females in the control group were compared. There was no effect of gender (unpaired t-test, p=0.85). The correlation between age and threshold was plotted. This shows a trend towards a decrease in sensitivity (represented by an increase in the value of the FST) of 0.13 dB per year in the control group (r=0.40, p=0.02), but a higher rate 0.5 dB change per year in the patient group (r=0.56, p<0.0001).

**Conclusions:** Scotopic vision, as assessed with the FST, declines with age and is further reduced in choroideremia patients and. Female carriers also have impairment. FST is able to detect reduced rod function in choroideremia and since it includes the peripheral retina, it is complementary to existing measurements made such as visual acuity and microperimetry.

**Commercial Relationships:** Jasleen K. Jolly; Charles L. Cottriall, None; Markus Groppe, None; Robert E. MacLaren, University of Oxford (P), NightStaRx (C)

**Support:** Oxford BRC HJRWAC04.HM00  
**Clinical Trial:** NCT01461213

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**Program Number:** 622 Poster Board Number: B0121  
**Presentation Time:** 1:30 PM–3:15 PM  
**Longitudinal Ocular Photosensitivity Assessment of Healthy and Achromatopsic Subjects**  
*Mariela C. Aguilar1, 2, Alex Gonzalez1, Cornelis Rowaan1, Carolina P. De Freitas1, Karam A. Alawa1, Heather A. Durkee2, Alejandro Arboleda1, Florence Cabot1, Potyra R. Rosa1, Byron L. Lani2, Jean-Marie A. Parel1, 3.* 1Ophthalmic Biophysics Center, Department of Ophthalmology, Bascom Palmer Eye Institute, University of Miami Miller School of Medicine, Miami, FL; 2Anne Bates Leach Eye Hospital, Department of Ophthalmology, Bascom Palmer Eye Institute, University of Miami Miller School of Medicine, Miami, FL; 3Brien Holden Vision Institute, UNSW, Sydney, NSW, Australia; 4Ergonomics and Human Factors, Department of Industrial Engineering, College of Engineering, University of Miami, Coral Gables, FL.

**Purpose:** To characterize ocular photosensitivity of healthy and Achromatopsic subjects.

**Methods:** The full-field stimulus threshold (FST) is a measure of absolute scotopic threshold (in dB) and is a summed response across the retina. FST was therefore used to assess scotopic thresholds in a large cohort of patients with choroideremia. FST measurements were made using the Espion 2 (Diagnostics LLC, Cambridge, UK). In order to characterise scotopic function in choroideremia, patients (n=56) attending screening appointments for the gene therapy trial (NCT01461213) underwent FST testing, following 45 minutes dark adaptation. Additionally, a cohort of normal age-matched controls (n=34) and female choroideremia carriers (n=10) were also assessed with FST. All comparative statistics were conducted on the right eye only (tested first).

**Results:** The FST threshold values (mean ± SEM) in the patient group were -21.2 ± 2.0 dB, choroideremia carrier group -43.9 ± 2.4 dB, and control group -51.8 ± 0.7 dB. All three groups were significantly different to each other (Kruskal-Wallis ANOVA, p<0.0001 for all points). Males and females in the control group were compared. There was no effect of gender (unpaired t-test, p=0.85). The correlation between age and threshold was plotted. This shows a trend towards a decrease in sensitivity (represented by an increase in the value of the FST) of 0.13 dB per year in the control group (r=0.40, p=0.02), but a higher rate 0.5 dB change per year in the patient group (r=0.56, p<0.0001).

**Conclusions:** Scotopic vision, as assessed with the FST, declines with age and is further reduced in choroideremia patients and female carriers also have impairment. FST is able to detect reduced rod function in choroideremia and since it includes the peripheral retina, it is complementary to existing measurements made such as visual acuity and microperimetry.

**Commercial Relationships:** Jasleen K. Jolly; Charles L. Cottriall, None; Markus Groppe, None; Robert E. MacLaren, University of Oxford (P), NightStaRx (C)

**Support:** Oxford BRC HJRWAC04.HM00  
**Clinical Trial:** NCT01461213

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**Purpose:** Achromatopsia is a genetic disorder characterized by decreased vision, discomfort when exposed to light, and an inability to differentiate color. The purpose of this study was to determine the stability and reliability of the Ocular Photosensitivity Analyzer (OPA) using healthy subjects over time and whether there is a significant change in photosensitivity thresholds over time in achromatopsic subjects.

**Methods:** The OPA generates a light stimulus using 210 white LEDs mounted on a bi-cupola concave surface providing varying light intensity in logarithmic ascending and descending steps ranging from 0 to 4.51 log(lux) (1 to 32,000 lux). The subject is instructed to indicate whether the light stimulus is uncomfortable by pressing a hand-held button and the photosensitivity threshold is calculated after 10 response reversals. Catch trials were programmed into the OPA software to ensure the subjects’ response reliability throughout the test. Power output and irradiance were measured to ensure the OPA meets safety exposure limits set forth by the ISO standard for ophthalmic instruments. Nine healthy (5 females and 4 males, age = 31.4±7.6 years) and four achromatopsic subjects (2 females and 2 males, age = 10.5±4.4 years) were tested under an IRB approved protocol. Photosensitivity of healthy and achromatopsic subjects were measured at 0, 2, 12, 40, and 379 days and at 0, 6 and 12 months, respectively. A one-way analysis of variance was performed within each of the subject groups to determine significance in the photosensitivity thresholds between time points.

**Results:** The mean photosensitivity threshold up to 379 days for healthy subjects was 3.27±0.13 log(lux). No significant change was noted for healthy subjects (p=0.98), demonstrating the reliability of the OPA. The mean photosensitivity threshold between 0 and 12 months for achromatopsic subjects was 0.48±0.52 log(lux). Despite the larger standard deviation, the change in the photosensitivity thresholds for achromatopsic subjects was not significant (p=0.71) within 12 months.

**Conclusions:** The OPA is a safe and reliable instrument to perform longitudinal determinations of the photosensitivity thresholds in subjects. Healthy and achromatopsic subjects demonstrated no significant change in photosensitivity thresholds at varying time points. Ongoing studies are being performed with this system to increase our subject population and further validate our findings.
Early to Intermediate AMD: Baseline Update

Lori A. Lott1, Marilyn E. Schneck1 2, Gunilla Haegerstrom-Portnoy1 2, Susan Hewlett1, Bonnie Gauer1, John A. Brabyn1.

1Smith-Kettlewell Eye Research Institute, San Francisco, CA; 2School of Optometry, University of California, Berkeley, California, CA.

Methods: Participants are individuals with E- or I-AMD, or age-matched controls with no AMD (C). Best-corrected high contrast visual acuity was ≥0.3 log [i.e. 2 times] worse than normal for all tests, E-AMD performance on most measures fell between that of C and I-AMD. The greatest differences between C and I-AMD were seen for SDH (0.2 log difference) and DesatCCS (0.6 log difference). Furthermore, when categorized as pass/fail (failure ≥ 0.3 log [i.e. 2 times] worse than normal for each test), E- and I-AMD groups fail significantly more tests than C.

Conclusions: We hypothesize that non-standard vision tests can predict which E/I AMD patients will develop advanced AMD. A true test of this hypothesis will require several years of follow-up study to determine which participants convert to advanced disease. Preliminary data from this baseline sample suggest that these measures should allow better prediction of disease progression.

Commercial Relationships: Lori A. Lott; Marilyn E. Schneck, None; Gunilla Haegerstrom-Portnoy, None; Susan Hewlett, None; Bonnie Gauer, None; John A. Brabyn, None

Support: NIH Grant EY023320, NIDILRR Grant 90RE5008-02-01

Program Number: 625 Poster Board Number: B0124

Presentation Time: 1:30 PM–3:15 PM

Temporal, spatial and chromatic sensitivity losses associated with OPA1 mutations

Anna Majander1, Patrick Yu-Wai-Mari1 2, Catarina João1, Marcela Votruba3 4, Anthony T. Moore1 2, Andrew Stockman1, 3

1Institute of Ophthalmology/Moorfields Eye Hospital, University College London, London, United Kingdom; 2Wellcome Trust Centre for Mitochondrial Research, Newcastle University and Newcastle Eye Centre, Royal Victoria Infirmary, Newcastle upon Tyne, United Kingdom; 3Institute of Ophthalmology, University College London, London, United Kingdom; 4School of Optometry and Vision Sciences, Cardiff University, Cardiff, United Kingdom; 5Cardiff Eye Unit, University Hospital Wales, Cardiff, United Kingdom; 6Ophthalmology Department, UCSF School of Medicine, San Francisco, CA.

Purpose: Autosomal dominant optic atrophy (DOA) caused by OPA1 gene mutations leads to retinal ganglion cell (RGC) loss, but the pattern and chronology of loss remain poorly understood. Our aim was to characterise psychophysically the visual losses caused by DOA, and to infer any selective or progressive losses in the distinct visual pathways subserved by different RGC types.

Methods: The participants were 11 patients with pathogenic OPA1 mutations and 15 age-matched healthy individuals. Achromatic spatial contrast sensitivity was measured as a function of spatial frequency. Long (L-) and short-wavelength (S-) sensitive cone temporal acuities were measured as a function of target illuminance, and L-cone temporal contrast sensitivity as a function of temporal frequency. Chromatic contrast sensitivity was measured using the Cambridge Colour Test. Spearman’s rank correlation and ANCOVA tests were used for the statistical analyses. OPA1 patients underwent an ophthalmologic investigation.

Results: Spatial contrast sensitivity was impaired in all OPA1 patients (1.58±0.04, normal 2.23±0.03 [mean log unit ± SEM]) with the loss increasing with spatial frequency. Chromatic thresholds along the Protan and the Deutan axes were 8 and 9 times higher than normal with age-related regression (Spearman r=0.673, p=0.023). L-cone temporal acuity was impaired peaking at 29.9±0.9 Hz (normal 40.2±0.9 Hz [mean ± SEM]) and contrast sensitivity suppressed by 0.5 log unit. Chromatic thresholds along the Tritan axis were 14 times higher than normal with age-related regression (Spearman r=0.725, p=0.012). The S-cone temporal acuity showed even steeper age-related decline (Spearman r=0.916, p<0.001) that was significantly different from normal (ANCOVA, p=0.002).

Conclusions: Midget RGC loss can be linked to the loss of high spatial frequency sensitivity in DOA, and (given midget RGCs also subserve red-green colour vision) to the increased Proton and Deutan thresholds. The loss of high temporal frequency sensitivity by contrast can be linked to parasol RGC loss. The most striking visual losses, however, were for the S-cone mediated chromatic and temporal sensitivities, which can be linked to small bistratified RGCs.
Program Number: 626 Poster Board Number: B0125
Presentation Time: 1:30 PM–3:15 PM
Vision function in individuals with diabetes and moderate to severe diabetic retinopathy with and without diabetic macular edema
Marilyn E. Schneck1, 2, Shirin Barez1, 3, Optometry, UC Berkeley, Berkeley, CA; 2Smith-Kettlewell, San Francisco, CA.
Purpose: To determine which psychophysical measures of foveal function can distinguish among three groups of eyes with moderate-severe diabetic retinopathy: eyes with No Edema, eyes with clinically significant macular edema (CSME), and eyes with diabetic macular edema elsewhere in the macula (DME-E).
Methods: Eyes were classified into 1 of the 3 groups according to the grading of dilated color fundus photographs by a retinal specialist. Fifty-five eyes (34 No Edema; 5 DME-E; 16 CSME) are included in the analyses. Foveal function was assessed using several simple, rapid, clinically practicable tests: standard (high contrast) visual acuity (VA); low contrast VA (LCVA); low contrast acuity at reduced luminance measured using the dark chart of the SKILL card (SKD); contrast sensitivity (CS; Pelli-Robson chart); and color vision (color confusion score [CCS] of the Adams desaturated D-15). Testing was monocular. A non-parametric test (Kruskal-Wallis) was used to evaluate potential differences among groups. For significant differences, post-hoc pairwise comparisons were carried out using the Mann-Whitney U test.
Results: Neither VA nor LCVA differs among the 3 groups (p> 0.05). CS and SKD show marginally significant differences among the groups (p= 0.04 and 0.02, respectively). However, given the multiple comparisons, only the D15 CCS differs significantly among groups (p<0.002). The median CCS of the CSME group is highest (76.00) and is significantly different (P=0.004) from the No Edema group (CCS= 17.18), but neither of these groups differ significantly from the DME-E group, which has a median CCS between the other 2 groups (CCS=42.81). A CCS of ≥ 30 was considered to be abnormal. Using this criterion, the frequency of abnormalities for the CSME group and the DME-E group are very similar (62.5% vs 60% respectively) and 3 times the rate of abnormalities seen in the No Edema group (20.6%). Among those that fail, approximately 60% of each group show a blue-yellow defect pattern in each group. These findings suggest that edema outside the fovea may also affect color vision.
Conclusions: Color vision, assessed with the Adams desaturated D-15 test is sensitive to the presence of CSME, and is also affected by more peripheral edema (DME-E).
Hemifield Test (GHT). Two new indices were investigated: 1) Right/Left Standard Deviation (R/L SD) of differences; 2) Number of test Pairs (R/L NP) outside 95% CL of controls. Both indices were derived for whole field data (44 test pairs) and for hemi field data (2×2 test pairs). ROC curves were generated for the R-L indices along with those for 3 unioocular worse eye hemifield indices: 1) GHT; 2) Hemifield Standard Deviation of differences; 3) Hemifield Number of Pairs outside 95% CL.

**Results:** The control and POAG samples median MD was 0.29dB (IQR=1.07) and -2.44dB (IQR 1.55) while the median absolute MD differences between the two eyes were 0.47dB (IQR 0.61) and 0.99dB (IQR 1.21). Figure 1 gives the ROC curves for all indices. Unioocular worse eye hemifield indices performed better than the new R/L eye asymmetry indices. were R/L MD=0.870 (95% Confidence Interval (CI) 0.828-0.911), R/L SD=0.925 (95% CI 0.894-0.957), R/L NP=0.899 (95% CI 0.862-0.936) and GHT=0.794 (95% CI 0.743–0.845) and hemifield analysis, area under the ROC for HMD, HNP and HSD were: 0.899 (95% CI 0.855-0.924), 0.945 (95% CI 0.925-0.966) and 0.963 (95% CI 0.948-0.978) respectively.

**Conclusions:** R/L asymmetry analysis has good discriminatory power but did not perform better than worse eye unioocular hemifield asymmetry indices. The performance of GHT was similar to that of combined unioocular indices in differentiating between normal and POAG eyes.

**Commercial Relationships:** Naqibah Ghazali, None; David Henson, None

**Clinical Trial:** National Research Ethics Services NHS UK, 10/H1011/34

**Program Number:** 629 Poster Board Number: B0128

**Presentation Time:** 1:30 PM–3:15 PM

**Analysis of Retinal nerve fiber layer in Mild cognitive impairment and Alzheimer disease**

**Do Gyun Kim, Jin Young Kwon.** ophthalmology, Myong-jii Hospital, Seonam University Medical college, Goyang-si, Gyenoggi- do, Korea (the Republic of).

**Purpose:** To compare the retinal nerve fiber layer (RNFL) and macula in the eyes of healthy older persons with no cognitive disabilities with that in the eyes of older people with mild cognitive impairment (MCI) or Alzheimer’s Disease (AD) using optical coherence tomography (OCT) to determine its effectiveness for early diagnosis of MCI or AD

**Methods:** Thirty eyes of 30 subjects in each cohort of normal eyes and those in patients with MCI or AD were studied. All subjects underwent ophthalmologic and cognitive examinations and measurements of RNFL thickness, and macular volume and thickness using OCT.

**Results:** Mean RNFL thickness on OCT was significantly thinner in the AD group than in the MCI group (p = 0.01). The RNFL was thinner in the superior quadrant in patients with AD compared to the healthy controls (p = 0.03). The RNFL thickness in the inferior, nasal, and temporal quadrants did not differ significantly among groups. Measurements in 12 zones revealed that zone 11 had a significantly thinner RNFL in the AD group compared with the healthy control group (p = 0.02). In zone 2, the MCI group had a significantly thinner RNFL than the AD group (p = 0.03).

**Conclusions:** Our findings revealed a neuroanatomic difference in the RNFL thickness among the three groups of AD, MCI and healthy controls on OCT, suggesting that a change in the average RNFL thickness could be one of several meaningful index for implying early AD.

**Commercial Relationships:** Do Gyun Kim, None; Jin Young Kwon, None

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A Comparison of the Medmont Dark Adapted Chromatic Perimeter (DAC) with the Full-Field Stimulus Threshold (FST) in Subjects with Retinitis Pigmentosa (RP)  

**Martin Klein**, Lea D. Bennett, Kelly Kiser, Paulina Mejia, Kelly Reddin, David G. Birch  

1 Retinal Degenerations Laboratory, Retina Foundation of the Southwest, Dallas, TX; 2 Ophthalmology, UT Southwestern Medical Center, Dallas, TX.  

**Purpose:** Many retinal degenerative diseases initially involve the rod photoreceptors, making rod-mediated vision an attractive outcome measure for treatment trials. However, previously established rod measurements yielded either a single summed electrical response from all rods (full-field ERG) or a single psychophysical threshold response from, presumably, the most sensitive area of the retina (Full-Field Stimulus Threshold, FST - 1. Roman A, et al. Physiol. Meas. 2007; 2. Klein M., Birch D.G. Doc. Ophthalmol. 2009; 3. Messias K, et al. Doc. Ophthalmol. 2013). The Dark-Adapted Chromatic (DAC) perimeter (Medmont Int PTY LTD; Nunawading, Australia) is a new LED driven, static visual field covering a wide area over a large dynamic range (75 dB). Here we compared DAC measurements to the FST.  

**Methods:** Thirteen subjects with RP were dilated in the eye with worse acuity and dark-adapted for 45 minutes. Seven normal subjects served as controls. Subjects were tested first with the DAC and then with the FST. The DAC presented 505 nm stimuli (0 dB = 0.4 log cd.s/m²; range bright to dim: 0 dB – 75 dB) over an area of 144 degrees horizontally and 72 degrees vertically. Total threshold was the sum of the inverse sensitivity measures from 164 locations. Minimum threshold was the lowest threshold of a single spot. The FST was performed as described previously (0 dB = -1.0 log cd.s/m²; range dim to bright: -75 dB to 30 dB) yielding a single threshold. The DAC and FST results are presented as the log threshold elevation from the normal average (DAC current, FST published).  

**Results:** Total and minimal threshold elevations were strongly correlated with each other (r=0.93, p<0.001) and with FST elevations (r=0.89, p<0.001, r=0.90, p<0.001, respectively). However, the Bland-Altman test revealed a 0.56 log unit bias toward smaller FST elevations when compared to the minimum threshold elevation.  

**Conclusions:** The DAC is a useful tool for testing location-based rod-mediated vision, however, the more sensitive FST may be more useful when testing very advanced subjects. The fact that both the DAC minimum and total threshold elevation correlated well with the FST elevation suggest that the FST may not be determined by the most sensitive spot in the retina as previously assumed, but could be driven by summation similar to the ERG.  

**Commercial Relationships:** Martin Klein, None; Lea D. Bennett, None; Kelly Kiser, None; Paulina Mejia, None; Kelly Reddin, None; David G. Birch, None  

**Support:** Foundation Fighting Blindness, EY09076

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**Program Number:** 631 Poster Board Number: B0130  
**Presentation Time:** 1:30 PM–3:15 PM  
**A Comparison of the Medmont Dark Adapted Chromatic Perimeter (DAC) with the Full-Field Stimulus Threshold (FST) in Subjects with Retinitis Pigmentosa (RP)**  

- Martin Klein  
- Lea D. Bennett  
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**Conclusions:** The DAC is a useful tool for testing location-based rod-mediated vision, however, the more sensitive FST may be more useful when testing very advanced subjects. The fact that both the DAC minimum and total threshold elevation correlated well with the FST elevation suggest that the FST may not be determined by the most sensitive spot in the retina as previously assumed, but could be driven by summation similar to the ERG.  

**Commercial Relationships:** Martin Klein, None; Lea D. Bennett, None; Kelly Kiser, None; Paulina Mejia, None; Kelly Reddin, None; David G. Birch, None  

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**Program Number:** 632 Poster Board Number: B0131  
**Presentation Time:** 1:30 PM–3:15 PM  
**Home-Based Self-Assessment of the Contrast Sensitivity Function in Age-Related Macular Degeneration**  

- Peter Bex  
- Michael Dorr  
- Kameran Lashkari  
- Luis A. Lesmes  
- Zhong-Lin Lu  
- Emily K. Wiecek  

1 Northeastern University, Boston, MA; 2 Adaptive Sensory Technology, Boston, MA; 3 Technische Universität München, Munich, Germany; 4 Harvard Medical School, Boston, MA; 5 Ohio State University, Columbus, OH; 6 New England College of Optometry, Boston, MA.  

**Purpose:** Detection of the onset or progression of vision loss from blinding eye diseases such as age-related macular degeneration (AMD) requires precise assessment with sensitive endpoints. Home testing has the potential to improve the frequency and convenience of testing and thereby improve screening, healthcare provision and clinical trial design. Standard vision tests, such as acuity and Amsler grids that could be self-administered in the home lack the precision needed for effective telemedicine. We evaluate the potential of a self-administered test of the contrast sensitivity function (CSF).  

**Methods:** The binocular CSFs of 21 AMD patients were measured using the quick CSF (Lesmes et al JoV 2010), self-administered on a tablet computer (Dorr et al IOVS 2013). The quick CSF algorithm adaptively changed the peak spatial frequency and contrast of a sequence of 50 band-pass filtered letter trials, to converge on the observer’s CSF. The observer’s 10AFC task after each stimulus was to report the identity of the letter on a touch-response screen. On the first and last day of the study, testing was supervised in the clinic, then every day over a period lasting at least 2 weeks, testing was unsupervised in the patient’s home. After each test, encrypted data were automatically uploaded to a secure server.  

**Results:** Consistent with our previous studies, patients with AMD showed reliable CSF deficits compared with age-matched controls. Unsupervised CSFs measured in the home were not significantly different from those measured under supervision in the clinic. The mean test-retest repeatability (standard deviation of the area under the log CSF) of home tests was 0.108 log10 units (range 0.044 – 0.26), which is better than the repeatability of most clinic-based, supervised vision tests in those with retinal disease.  

**Conclusions:** The quick CSF test can be reliably self-administered outside the clinic without supervision and may therefore form part of an effective program for monitoring people who have or are at risk of eye disease. It could be a precise and sensitive endpoint for detecting changes in visual function caused by the presence or progression of vision loss in AMD. The ability to increase the frequency of testing without imposing additional burden on patients has the potential to increase the statistical power and dramatically reduce the sample size and duration of clinical trials.  

**Commercial Relationships:** Peter Bex, Michael Dorr, Adaptive Sensory Technology (P), Adaptive Sensory Technology (I); Kameran Lashkari, None; Luis A. Lesmes, Adaptive Sensory Technology (I), Adaptive Sensory Technology (P), Adaptive Sensory Technology (F), Adaptive Sensory Technology, Zhong-Lin Lu, Adaptive Sensory Technology (I), Adaptive Sensory Technology (P), Adaptive Sensory Technology (C); Emily K. Wiecek, None  

**Support:** R43EY023902

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**Program Number:** 633 Poster Board Number: B0132  
**Presentation Time:** 1:30 PM–3:15 PM  
**Factors Influencing Visual Acuity in Fuchs’ Endothelial Corneal Dystrophy**  

- Hidenaga Kobashi  
- Kazutaka Kamiya  
- Akihito Igarashi  
- Kimiya Shimizu  

Department of Ophthalmology, University of Kitasato School of Medicine, Sagamihara, Japan.  

**Purpose:** To evaluate the factors affecting corrected distance visual acuity (CDVA) in patients with Fuchs’ endothelial corneal dystrophy (FECD).  

**Methods:** We retrospectively examined 31 eyes of 21 consecutive patients (age, 68.5±11.2 years [mean ± standard deviation]) with patients with FECD. Stepwise multiple regression analysis was used to assess the factors affecting the CDVA.  

**Results:** The mean logMAR CDVA, endothelial cell density (ECD), central corneal thickness (CCT), corneal astigmatism, objective scattering index (OSI), corneal density, and corneal higher-order aberrations (HOAs) was 0.08±0.22, 1892±590 /mm², 572±52 μm, 1.52±1.26 diopters, 6.60±4.30, 24.41±7.78, and 0.35±0.19 μm, respectively.
respectively. Explanatory variables relevant to the CDVA were, in order of influence, OSI (partial regression coefficient $B=0.037$, $p=0.001$) and corneal density ($B=0.009$, $p=0.035$) (adjusted $R^2=0.694$). Multiple regression was expressed by the following equation:

$$CDVA = (0.037 \times OSI) + (0.009 \times \text{corneal density}) - 0.843.$$  

No significant correlation was seen with other clinical factors such as age, ECD, CCT, corneal astigmatism, or corneal HOAs. Similar results were obtained by Spearman rank correlation test (Figure 1 and Figure 2).

**Conclusions:** Eyes with higher light scattering, especially higher forward light scattering are more predisposed to show deteriorated visual acuity. Intraocular forward light scattering can be useful to evaluate the visual performance and determine the surgical indications of endothelial keratoplasty for eyes with FECD.

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**Figure 1.** A graph showing a significant correlation between the corrected distance visual acuity and the objective scattering index (Spearman correlation coefficient $r=0.779$, $p<0.001$).

**Figure 2.** A graph showing a significant correlation between the corrected distance visual acuity and the corneal density (Spearman correlation coefficient $r=0.412$, $p=0.021$).

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**Program Number:** 634  **Poster Board Number:** B0133

**Presenting Author:** Kimiya Shimizu

**Purpose:** Low vision is associated with a wide range of acuity reduction. Simulating visual information loss due to acuity reduction can provide tools for visualization of the real-world challenges faced by people with low vision. The purpose of this study is to validate and compare two image-processing models, one linear and the other nonlinear, that aim to simulate acuity loss.

**Methods:** Both models implement a spatial-frequency filter based on a contrast-sensitivity function (CSF), shifted on the frequency axis to represent acuity reduction. The linear model scales the spatial frequency content of an image by the ratio of the shifted to unshifted CSF. The non-linear model, based on Peli (1990), decomposes a visual image into a discrete set of frequency bands and applies a hard threshold to each band using the acuity-shifted CSF. Both models were tested psychophysically on subjects with normal vision in a letter recognition task. Sloan letters filtered by either model were presented individually on each trial, simulating different levels of visual acuity from 0 (normal) to 1.5 in logMar. To investigate how stimulus contrast interacts with acuity loss, the Michelson contrast of letters were 20%, 50% or 80%. Eight subjects completed 1800 trials with letters varying in nominal logMar size, contrast and simulated acuity loss. Effective acuity was measured as the logMar size of letters that yielded 75% correct performance for each stimulus contrast and simulated acuity loss.

**Results:** Both models successfully simulated different levels of acuity reduction. For both models and for all subjects, measured acuity regressed linearly with simulated acuity at a slope close to unity, with the non-linear model approaching closest to the theoretical unity line. Measured acuity showed a clear contrast-dependence such that acuity dropped steadily with reduced letter contrast, which was more pronounced for the non-linear model. Informal observation suggested that the non-linear model is more robust than the linear one with respect to moderate variations in viewing condition.

**Conclusions:** Acuity loss in low vision can be simulated by either a linear or non-linear model with qualitatively similar performance characteristics. Both models provide a tool to visualize and investigate visual challenges commonly encountered by people with low vision in the real world. Further work is needed to determine the selection of the two models for specific applications.

**Commercial Relationships:** None; Daniel Kersten

**Support:** NIH Grant EY017835

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**Program Number:** 635  **Poster Board Number:** B0134

**Presenting Author:** Quan Lei

**Purpose:** Improving patient outcome and proficient use of the Argus II Retinal Prosthesis

**Commercial Relationships:** Hidenaga Kobashi

**Commercial Relationships:** Kazutaka Kamiya

**Commercial Relationships:** Akihito Igarashi

**Commercial Relationships:** Kazutaka Kamiya

**Commercial Relationships:** Akihito Igarashi

**Commercial Relationships:** Kazutaka Kamiya

**Commercial Relationships:** Akihito Igarashi

**Commercial Relationships:** Kazutaka Kamiya

**Support:** None; Gordon E. Legge

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**Program Number:** 635  **Poster Board Number:** B0134

**Presenting Author:** Quan Lei

**Purpose:** Improving patient outcome and proficient use of the Argus II retinal prosthesis may be achieved by incorporating consistent...
training in the home setting. Self-administered, computerized, visual rehabilitation training modules may help patients learn how to interpret the new visual input they perceive from their device. This study investigates the benefits of training with a computer-based, interactive software designed to improve on-screen object recognition, spatial tracking, and eye-hand coordination.

**Methods:** Computer-based training modules were programmed using National Instruments Labview Development Suite (Austin, TX.). The patient is emailed a web link allowing the download and installation of each module. At the completion of each module data measuring accuracy and timing are programmatically transmitted back for analysis via secure email. The object recognition module presents the patient with random characters and symbols for identification. The user can adjust the size, brightness and position of the object to improve visualization. The spatial tracking module presents an on-screen object that moves in a pattern (i.e. square, vertical figure eight, triangle, spiral, horizontal figure eight, heart, horizontal zig-zag, circle). The patient tracks and identifies the pattern of the animation. During the initial phase of the eye-hand coordination module, the patient becomes familiar with using the computer mouse to move an enlarged on-screen cursor. In the second phase the patient is presented with on-screen targets to click on with the cursor.

**Results:** Consistent use of the training modules showed significant improvements in accuracy and completion time. Target localization accuracy improved 85.5% after 3 trials, character recognition improved 50% accuracy after 7 trials and pattern tracking improved 33% after 5 trials. Performance accuracy decreased 51.9% when the Argus II device was not used.

**Conclusions:** Incorporating interactive, computer based training at patient’s home can improve interpretation of the visual precepts delivered by the Argus II retinal prosthesis.
pupil constriction (PPC), maximal constriction velocity (MCV) and the latency of MCV (LMCV) were determined. In the eye study, 13 patients with retinal dystrophy, 5 patients with macular dystrophy and 27 aged-matched controls were included. Patient’s CMP results were compared to subjective VF testing [Humphrey 24-2 VF (HFA-VF) or Dark Adapted Goldmann VF (DA-GVF)]. In the brain study, 12 cognitively normal, subjects (ages 60-74) were included and CMP results were associated with cognitive (Montreal Cognitive Assessment, MoCA) testing.

**Results:** In retinal dystrophy patients, test points in which the PPC was lower than 4 standard errors (SEs) away from the mean of controls correlated with VF areas that were abnormal by DA-GVF. The variability in LMCV between different test points in response to red light was significantly higher in patients (range: 0.16-0.47) than in controls (range: 0.02-0.16; p<0.0001) and indicated its usefulness as a diagnostic tool with high sensitivity and specificity (Mann–Whitney–Wilcoxon analysis, area under the curve = 0.97.) Patients with macular degeneration demonstrated reduced PPC and MCV, more than 2 SEs away from the mean of controls, in response to red light in the majority of central (16 degree) HFA-VF locations. In the brain study, low MoCA (<26) was associated with reduced PPC in response to red light in the nasal region compared to normal MoCA (≥26) (3.3% [SE=0.3] vs 10.1% [SE=0.8]; p=0.018). Subjects with MoCA<26 compared to MoCA ≥26 showed reduced PPC in response to blue light in all regions except the inferior (nasal 5.8% vs 15.1% p=0.032; temporal 4.6% vs 13.9% p=0.028; superior 4.8% vs 13.8% p=0.033).

**Conclusions:** This study demonstrated the feasibility of using the CMP for identification of defects in visual pathways in different locations of the retina associated with VF defects and cognitive impairment. Different parameters of pupil response to chromatic multifocal stimuli may clarify the pathophysiology of different neurodegeneration diseases.

**Commercial Relationships:** Ygal Rotenstreich, Accutome Inc (F), Accutome Inc (P); Daniel Ben Ner, None; Ron Chibel, None; Yakir Berchenko, None; Bernice Oberman, None; Ofra Kalter-Leibovici, None; Laurence Freedman, None; Michal Beeri, None; Ramit Ravona-Springer, None; Sagi Harnof, None; Ifat Sher-Rosenthal, None

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