Purpose: For patients with age-related macular degeneration (AMD) and controls with normal vision, we examined the closed-loop gain of horizontal and vertical smooth pursuit eye movements as a function of stimulus speed and direction. We hypothesized that the smooth pursuit gain functions would be affected by stimulus speed and by the location of the preferred retinal locus (PRL) in relation to the scotoma as determined by microperimetry. Specifically, that a PRL on the left of the scotoma in the visual field would decrease the rightward gain as compared to the leftward gain and that a PRL below the scotoma in the visual field would decrease the upward gain relative to the downward gain.

Methods: Ten patients and 15 controls were tested in a step-ramp procedure with direction (left/right for horizontal motion; up/down for vertical motion), speed (5, 10, 15, 20 and 30 deg/sec) and 5 replication conditions randomized and blocked by orientation (horizontal vs vertical). Eye movements were binocularly recorded at 120 Hz. The weighted mean closed loop gain of smooth pursuit was obtained after saccades, blinks and artifacts were removed from the records. PRL location was determined with the MP-1 microperimeter.

Results: Three PRL locations (near central, left and above the scotoma on the retina) were found in the better eye of the patient group. Overall, horizontal pursuit had a higher gain than vertical pursuit (p = 0.04 controls; p = 0.02 AMD). For the patients, the two eyes (better and worse) moved conjugately and had similar smooth pursuit gains in all tasks (p = 0.31 horizontal; p = 0.13 vertical). Regardless of PRL location, for horizontal pursuit all patients showed significantly better pursuit of leftward as compared to rightward motion (p = 0.004). For vertical pursuit, the patients’ downward pursuit also exhibited a higher gain than their upward pursuit (p = 0.02). The controls’ data did not exhibit a directional preponderance in either horizontal or vertical smooth pursuit (p > 0.05).

Conclusions: The PRL location was not predictive of the directional preponderance of pursuit performance. These results imply that patients may not use the PRL that was initially located during a static fixation task. Rather, they may adapt to the task by using a PRL that appears more suitable.

Commercial Relationships: Esther G. Gonzalez, None; Luminita Tarita-Nistor, None; Efrem Mandelcorn, None; Martin J. Steinbach, None

Support: Supported by the Krembil Research Institute and the Donald K Johnson Eye Institute

Program Number: 4691 Poster Board Number: B0643
Pursuing Perceptual Images in the Absence of Central Vision
Henry Y. Liu1, Esther G. Gonzalez2, 1, Luminita Tarita-Nistor2, Efrem Mandelcorn3, Martin J. Steinbach1, 2, 3
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Purpose: People can pursue perceptual as well as visual stimuli. We compared the smooth pursuit of patients with AMD and controls in two experiments. In the first, participants pursued the bottom vertex of a moving rhomboid and its amodally completed version covered by an occluder. In the second, participants tracked the imagined center of an invisible rolling wheel when all that they could see were either one (single cycloid) or two (double cycloid) points travelling in a cycloidal path on the rim of the wheel. We hypothesized that patients with AMD would be able to track both the completed and visible pursuit stimuli by using peripheral retinal information.

Methods: The eye movements of patients (n = 4) and controls with normal vision (n = 11) were monitored by an infrared eye tracker. In Experiment 1, the rhomboid moved in a predictable sinusoidal path or in a pseudorandom path created by the sum of several non-harmonic sine waves. For all participants we measured retinal slip (root mean square eye position error, or RMSD), mean peak velocity gain, saccade frequency, and saccade amplitude.

Results: AMD patients showed an overall increase in the magnitude of RMS error compared to controls (p = 0.009) with a corresponding reduction in gain (p = 0.006) and more saccades (p = 0.01) with higher amplitudes (p = 0.04) in both experiments. In Experiment 1, controls had significantly larger errors (p = 0.01) and lower gain (p < 0.0001) while tracking the unpredictable than the predictable stimulus path, and more errors (p = 0.001) and reduced gain (p = 0.0003) in the masked than in the unmasked conditions. The patients’ performance, on the other hand, depended on their visual acuity: 1) those with better acuity produced data similar to the controls, and 2) those with worse acuity exhibited better performance with the masked stimulus than with the unmasked stimulus and showed no differences as a function of stimulus predictability. In Experiment 2, controls exhibited better pursuit (i.e., lower RMSD) with the double cycloid than the single cycloid (p < 0.0001) but there was no difference for the patients (p > 0.05) due to poor eye movement control.

Conclusions: Consistent with our hypothesis, AMD patients are able to track a perceptually completed moving stimulus albeit with larger retinal slip and more saccadic eye movements. The pursuit of the cycloids path required a degree of ocular motor control that the patients lack.

Commercial Relationships: Henry Y. Liu, None; Esther G. Gonzalez, None; Luminita Tarita-Nistor, None; Efrem Mandelcorn, None; Martin J. Steinbach, None

Program Number: 4692 Poster Board Number: B0644
Presentation Time: 11:00 AM–12:45 PM
An automated system to assess eye movement characteristics for individuals with visual impairment in age-related macular degeneration
Damon W. Wong1, Ai Ping Yow1, Huiying Liu1, Fengshou Yin1, Hongyuan Zhu1, Ivy Ong1, Augustinus Laude1, Tock H. Lim1, 2
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**Purpose:** To introduce AVIGA, a system to automatically assess individuals with visual impairment from age-related macular degeneration (AMD) using characteristics of eye movements through eye gaze tracking.

**Methods:** AVIGA is an intelligent system to assess visual impairment in age-related macular degeneration using eye gaze tracking using a desktop mounted eye tracker (Tobii TX300). This system detects the location of an individual’s gaze in real time while projecting 33 test points sequentially in the visual field relative to the gaze point dynamically, avoiding the need for a static eye fixation point. Eye movement characteristics from the gaze data are then automatically detected and measured by the system. Specifically, the eye gaze excursion during each test is characterized by the convex hull of the path (convex path area) travelled by the detected eye gaze during each projected target point in the visual field. The system is evaluated on eyes from healthy subjects and eyes with AMD-related visual impairment diagnosed clinically. Micropereimetry (Nidek MP-1) was used as the gold standard visual field assessment for AMD eyes. A repetition of the Purpose?

**Results:** 10 healthy eyes and 10 eyes with visual impairment from AMD were tested using the AVIGA system. The difference between the mean convex path area for healthy eyes (11.2, s=3.01) and that of AMD eyes (53.3, s=21.3) was found to be significant (p<0.05). The Pearson’s correlation coefficient was determined to be 0.73 between the visual field assessment based on seen projected points from the proposed AVIGA system against micropereimetry.

**Conclusions:** There is a significant difference in the gaze movements between healthy eyes and AMD eyes as assessed by the proposed AVIGA system. Evaluation against micropereimetry for AMD eyes showed good correlation with AVIGA. The results suggest that AVIGA could be used as a tool for the detection and monitoring of eyes with AMD.

**Commercial Relationships:** Damon W. Wong, None; Ai Ping Yow, None; Huiling Liu, None; Fengshou Yin, None; Hongyuan Zhu, None; Ivy Ong, None; Augustinus Laude, None; Tock H. Lim, None

Program Number: 4694 Poster Board Number: B0646
Presentation Time: 11:00 AM–12:45 PM
A quantitative tool for automated optokinetic vision assessment
Jeremy Hill, 1, 2 Melis Sunar, 1, 2 Jason Carmel, 1, 2, Glen T. Prusky, 1, 2
1 Burke Medical Research Institute, White Plains, NY; 2 Blythedale Children’s Hospital, Valhalla, NY.
**Purpose:** Cerebral visual impairment (CVI) resulting from brain injury is difficult to assess, since brain injury often also impairs the ability to communicate. Established approaches using preferential looking paradigms or visual evoked potentials are impracticable and hence generally not used clinically. We designed, built and validated a system that automatically determines visual thresholds in humans based on objective quantification of optokinetic responses.

**Methods:** Our system uses a screen to present band-limited stimuli that move continuously at 12 deg/sec, while a desktop eye-tracker monitors eye movements. An automated algorithm determines whether subjects’ eyes move smoothly with the stimulus, tolerating occasional reverse saccades. The output drives real-time feedback in the form of music, to keep subjects engaged in the task. It also drives adaptive adjustment of contrast or spatial frequency, to find the threshold at which smooth tracking is 75% successful.

**Results:** First, we asked whether this system could make valid, reliable measurements of spatial vision. We used it to measure contrast thresholds at 8 different spatial frequencies in 4 healthy adults. The contrast sensitivity functions were (a) repeatable between subjects, (b) repeatable within-subject, and (c) inverted-U-shaped, suggesting that they reflected mechanisms of spatial vision. Second, we asked whether the system could provide valid measures of acuity. In 8 healthy adults tested with and without optical correction, we found a good correlation (r=0.88; p<0.001) between spatial-frequency tracking thresholds and LogMAR acuity measured using a tumbling-E chart. Furthermore, in 13 children with brain injury who could communicate, we found a good correlation (r=0.74; p<0.01) between spatial-frequency thresholds and the LogMAR equivalent of their clinically assessed Snellen acuity.

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Third, we asked whether the system was applicable to children with brain injury who could not communicate. 9 such children were tested. Their spatial-frequency thresholds spanned the same range as the 13 verbal children. We were able to perform repeated measurements with 15 of the 22 children, and the test-retest correlation was 0.86. **Conclusions:** These results indicate that our approach is a promising method of quantitative visual function assessment, and that it can be used even in cases where no other objective vision assessment is possible.

**Commercial Relationships:** Jeremy Hill, OptokineSys (US application #62/185,983) (P); Melis Suner, None; Jason Carmel, OptokineSys (US application #62/185,983) (P); Glen T. Prusky, OptokineSys (US application #62/185,983) (P)

**Support:** NIH Grant EY026753; The Thomas & Agnes Carvel Foundation; Blythedale Children's Hospital

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**Program Number: 4695 Poster Board Number: B0647**

**Presentation Time:** 11:00 AM–12:45 PM

Do ocularmotor adaptations to a volume scotoma provide functional benefits for binocular vision?

**Concetta F. Alberti, Peter Bex.** Psychology, Northeastern University, Boston, MA.

**Purpose:** Binocular eye movements can adjust the projection of a retinal volume scotoma (Arditi, 1988) and modify the retinal disparity of targets in depth. We recently showed (Alberti et al, ARVO 2015) that observers with gaze-contingent simulated independent scotomas make binocular eye movements that move the location of the volume scotoma. We assessed whether such adaptations improve binocular contrast sensitivity in the peripheral visual field.

**Methods:** The contrast sensitivity function was measured with a 26AFC task in which normally-sighted observers (N=6) identified bandpass filtered letters whose spatial frequency and contrast were varied with modified quickCSF algorithm (Lesmes et al, 2010). The letters were positioned 2° in the lower visual field and, in randomly interleaved trials, were either in corresponding retinal locations or displaced horizontally by ±0.25 letter widths to create near or far visual disparity. The gaze contingent scotoma in each eye was a Gaussian windowed (σ=0.5° OS and 1° OD) patch of pink noise, centered on the fovea. Dichoptic presentation of the stimuli was controlled with nVidia 3D glasses synched to a low-latency 144Hz display and eye tracking was measured at 1000Hz with an Eyelink II.

**Results:** The area under the logCSF (AULCSF) was lower for positive or negative disparity stimuli than for stimuli at zero disparity (mean 1.55 vs 1.73, p<0.001), as was peak contrast sensitivity (mean 1.43 vs 1.61, p<0.001). CSF acuity (the highest spatial frequency letter identifiable at full contrast) and other parameters of the CSF did not significantly vary with disparity.

**Conclusions:** In the peripheral visual field, binocular contrast summation requires spatially aligned stimuli and does not occur for disparity-defined targets. Thus ocularmotor adaptations that shift the location of a volume scotoma may assist fixation control, but are not associated with functional benefits in contrast sensitivity.

**Commercial Relationships:** Concetta F. Alberti, None; Peter Bex, Adaptive Sensory Technology (I), Adaptive Sensory Technology (P)

**Support:** NIH Grant 1K99EY026130-01

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**Program Number: 4696 Poster Board Number: B0648**

**Presentation Time:** 11:00 AM–12:45 PM

Exploration of the phenomenon of regression to the mean in visual acuity measurements in patients with age-related macular degeneration

**Simona Degli Esposti, Omar A. Mahroo, Praveen J. Patel, Adnan Tufail.** NIH Biomedical Research Centre for Ophthalmology, Moorfields Eye Hospital, London, United Kingdom.

**Purpose:** In clinical trials and real-world data, gains in visual acuity are frequently highest in those with lowest baseline acuity. Some of this effect may relate to the phenomenon of regression to the mean. We explored this by analysing visual acuity measurements made on two occasions in untreated eyes, and assessing change in visual acuity for those with the highest and lowest acuities.

**Methods:** Best-corrected ETDRS visual acuity recorded at baseline (“visit 1”) and week 1 (“visit 2”) from the untreated fellow eyes of participants in the ABC trial (Bevacizumab for neovascular age related macular degeneration; Tufail et al., BMJ, 2010) were analysed. Participants seeing fewer than 5 letters on either occasion were excluded. Those in the top and bottom 10% at visit 1 were identified, and the means compared between visits (visit 2 minus visit 1). The top and bottom 10% at visit 2 were also identified, and their means compared between visits (visit 1 minus visit 2).

**Results:** Ninety-nine patients were included. Mean (SD) age was 78.5 (6.9) years. Mean (SD) acuities were 63.7 (24.7) and 65.0 (25.1) for visits 1 and 2 respectively. For the top 10% at visit 1, the mean visual acuity changed by 0 letters between visits 1 and 2. For the bottom 10% at visit 1, mean visual acuity changed by +3.5 letters (p=0.14) by visit 2. When comparing backwards, for the top 10% at visit 2, the mean visual acuity changed by -1.25 letters (p=0.015), i.e. the mean for visit 1 was lower. For the bottom 10% at visit 2, the mean visual acuity changed by +4.4 letters (p=0.16), i.e. the mean for visit 1 was greater.

**Conclusions:** In this exploratory study, effects consistent with regression to the mean were observed. When eyes with the lowest 10% of visual acuities were identified at either visit, they appeared to improve their vision at the other visit irrespective of whether this was forwards or backwards in time. The effect appeared smaller/absent for the top 10%, which may be due to the lower variability in acuity measurements in this group. The regression to mean effect is greater the more the variability in the measurement.

**Commercial Relationships:** Simona Degli Esposti, Omar A. Mahroo, None; Praveen J. Patel, Salutari MD (R), Novartis (C), Merck Inc (C), Heidelberg Inc (F), Topcon Inc (F), Roche UK (C), Bayer (C), Thombogensics NV (C), Thombogensics NV (F), Genentech Inc (C); Adnan Tufail, Pfizer (C), Novartis (C), Thombogensics (C), GSK (C), Bayer (C), Allergan (C)

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**Program Number: 4697 Poster Board Number: B0649**

**Presentation Time:** 11:00 AM–12:45 PM

A higher contrast requirement for letter recognition in glaucoma

**Lillian Chien, Rong Liu, MiYoung Kwon.** Department of Ophthalmology, University of Alabama at Birmingham School of Medicine, Reno, NV.

**Purpose:** Glaucoma is a leading cause of world blindness, characterized by progressive loss of retinal ganglion cells. Unlike the conventional view that early glaucoma primarily affects peripheral vision, recent anatomical studies (e.g. Hood et al., 2013) have shown that glaucomatous injury involves the macula even in the early stages. However, little is known about whether and how this macular damage affects central visual function such as letter recognition. Here we examine whether glaucomatous damage requires a higher contrast for letter recognition in central vision.

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Methods: Nine subjects were recruited: patients with Primary Open-Angle Glaucoma (mean age=59.5±5.1 yrs; mean MD better eye=−13.6±12.0 dB; mean MD worse eye=−8.5±10.2 dB) and age-similar normally-sighted subjects (mean age=54.0±5.3 yrs). Contrast requirement for letter recognition was measured using a letter-recognition task in the central visual field; subjects identified English alphabet letters presented at eight locations in the central 15° visual field. The threshold contrast for letter recognition was defined as a contrast level that yields 80% recognition accuracy. The retinal ganglion cell plus inner plexiform (RGC+) layer thickness was measured using Spectral-Optical Coherence Tomography (OCT) in the macula (corresponding to the central 20° visual field). The RGC+ layer thickness at each letter location was calculated from the RGC+ layer thickness of corresponding retinal areas after correcting for the displacement of retinal ganglion cells.

Results: Compared to normal cohorts, glaucoma subjects showed a significant decrease in RGC+ layer thickness (by 19.2%, p<0.01). Similarly, glaucoma subjects showed a significant increase in the contrast threshold for letter recognition (by 107.4%, p=0.02). Furthermore, for both subject groups, RGC+ layer thickness significantly correlated with contrast threshold for letter recognition (r=−0.41, p<0.01).

Conclusions: Our results demonstrate that the RGC+ layer thickness is significantly thinner in the macula of glaucomatous eyes. This macular damage appears associated with a higher contrast requirement for letter recognition. Our findings further support the view that glaucomatosus injury involves the macula even in mild to moderate glaucoma.

Reference:

Commercial Relationships: Lillian Chien, None; Rong Liu, MiYoung Kwon, None

Purpose: To measure contrast sensitivity of diabetic patients using illiterate CamBlobs2 charts as a self-administered test, and to relate this to the different levels of diabetic retinopathy (DR).

Methods: DR of 105 eyes in 56 diabetic patients attending a diabetic eye clinic was graded using retinal photography (dilated pupils) with the ETDRS grading, and confirmed with fluorescein angiography, indirect ophthalmoscopy and OCT measurements as necessary. Patients had minimal lenticular changes and no other ocular disease. The different levels of retinopathy grades were: Grade 0 (none), Grade 1 (mild NPDR, Non Proliferative DR), Grade 2 (moderate NPDR), Grade 3 (severe NPDR/PDR, also graded as sight-threatening retinopathy STR). Contrast sensitivity was measured using hand-held CamBlobs2 charts. These are printed paper charts with 25 rows of round grey spots, each 9mm in diameter, whose log Weber contrast (logC), with respect to the white background, reduces by 0.05 on successive rows ranging from -0.80 at the top to -2.05 at the bottom. On each row of the chart there are 4 randomly spaced spots (all with the same contrast) whose location the subject marks with a pen. The subject’s contrast sensitivity is recorded as -logC of the spots on the uppermost row on which the location of no more than two spots has been correctly marked.

Results: Each increase in the level of severity of retinopathy was associated with a significant reduction in visual function as determined by LogMAR acuity or by CamBlobs2 contrast sensitivity. Receiver Operating Characteristic (ROC) curves were constructed. The area under the ROC curve for differentiating STR from earlier stages of retinopathy based on the contrast sensitivity data was 0.76±0.05, indicating moderately good sensitivity and specificity. Contrast sensitivity measured with CamBlobs2 for eyes with STR was 0.30±0.05 log units (p<0.001) less than for diabetic eyes with no retinopathy.

Conclusions: This pilot study shows that contrast sensitivity of patients with DR can be satisfactorily measured with a self-administered test using inexpensive printed paper charts. The reduction in contrast sensitivity associated with the progression of DR from none to STR is sufficiently large that it should be possible to identify it by periodically monitoring a patient’s contrast sensitivity using CamBlobs2 charts.

Commercial Relationships: John Robson, Precision Vision (P); Precision Vision (C); Rajiv Raman, None; Durgasri Jaisankar, None; Raju P. Sapkota, None; Shahina Pardhan, None

Program Number: 4699 Poster Board Number: B0651
Presentation Time: 11:00 AM–12:45 PM
Repeatability and Concordance of Visual Acuity Measured with ETDRS Number, ETDRS Landolt C, and Original ETDRS Alphabet Charts in Normal Eyes or Eyes with Sight-threatening Conditions
Voraporn Chaikitmongkol1, Onnisa Nanegrungsunk2, Direk Patikulsila1, Paisan Ruamviboonsuk3, Neil Bressler4, Retina Division, Department of Ophthalmology, Faculty of Medicine Chiang Mai University, Amphur Muang Chiang Mai, Thailand; Department of Ophthalmology, Chiang Mai University, Amphur Muang Chiang Mai, Thailand; Retina Division, Department of Ophthalmology, Rajivithi Hospital, Bangkok, Thailand; Retina Division, Wilmer Eye Institute, Baltimore, MD.

Purpose: In clinical trials, best-corrected visual acuity (BCVA) of non-English speaking individuals sometimes is measured with the ETDRS Landolt C chart, which may not reflect true BCVA in those with left-right confusion. Reliability of a commercial ETDRS numeric chart has not yet proven. This cross-sectional study evaluates repeatability and concordance of ETDRS number charts with the ETDRS Landolt C and ETDRS alphabet charts in normal eyes and eyes with sight-threatening conditions.

Methods: Following IRB approval, Thai participants who can speak English were recruited as group A: 60 participants with normal vision (BCVA 20/20-20/25); group B: 40 participants with BCVA 20/20-20/40 due to senile cataract (SC), diabetic macular edema (DME), or age-related macular degeneration (AMD); group C: 40 participants with BCVA 20/50-20/100 due to SC, DME, or AMD, and group D: 14 participants with BCVA 20/125-20/200 due to SC, DME, or AMD. Each participant underwent standardized BCVA measurements at 4 meters with three types of ETDRS charts (Precision-Vision®, Woodstock, IL) including PV numbered, Landolt C, and original alphabet charts in a random sequence, twice, with at least 30 minutes apart. Mean BCVA were analyzed for repeatability and concordance using Pearson’s correlation coefficient and intra-class correlation, respectively.

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Results: Of 154 participants (47% men, 154 study eyes), mean age was 52.9 (±18.2) years. Repeatability coefficients of the ETDRS number chart were 0.61 in group A (95% confidence interval [CI]: 0.42-0.75), 0.87 in group B (95% CI: 0.78-0.93), 0.81 in group C (95% CI: 0.67-0.90), and 0.81 in group D (95% CI: 0.49-0.94). Concordance correlation coefficients (CCC) between number and Landolt C charts were 0.61 (95% CI: 0.35-0.77) in group A, 0.83 (95% CI: 0.68-0.91) in group B, 0.77 (0.56-0.88) in group C, and 0.75 (0.22-0.92) in group D. CCC between number and original alphabet charts were 0.89 (0.82-0.93) in group A, 0.97 (0.94-0.98) in group B, 0.92 (0.86-0.96) in group C, and 0.96 (0.87-0.99) in group D.

Conclusions: These data suggest the ETDRS number chart can be used in non-English speaking individuals with normal vision or sight-threatening conditions with high repeatability, and high concordance with Landolt C and alphabet charts.

Commercial Relationships: Voraporn Chaikitmongkol, Allergan (R), ThermoGenics (F), Novartis (R), Bayer (R), Bayer (F); Onnisa Nanegrungsunk, None; Direk Patikulsila, Novartis (C), Bayer (C), Novartis (R), Bayer (R), Novartis (F), Allergan (C); Paisan Ruamviboonsuk, Novartis (C), Novartis (R), Bayer (C), Bayer (R), Allergan (C); Neil Bressler, Regeneron (F), Genentech/Roche (F), Novartis (F), Bayer (F)

Support: Funding from Faculty of Medicine, Chiang Mai University, Chiang Mai, Thailand

Program Number: 4700 Poster Board Number: B0652
Presentation Time: 11:00 AM–12:45 PM

Simulating Reduced Acuity in Low Vision: Visibility of Steps and Ramps at Different Hours of the Day

Quan-Lei1, Brent S. Carpenter2, Robert Shakespeare3, Daniel Kersten4, Gordon E. Legge1
1Department of Psychology, University of Minnesota Twin Cities, Minneapolis, MN; 2Department of Theatre, Drama, and Contemporary Dance, Indiana University Bloomington, Bloomington, IN.

Purpose: People with low vision have difficulty navigating in indoor spaces when key mobility features, such as steps and ramps, have low visibility. Visibility can vary due to overall lighting levels or to changes in the pattern of lighting throughout the day. We hypothesize that the more severe the acuity reduction, the more vulnerable is vision to adverse effects of lighting. The purpose of the current study is to investigate the interacting effects of changing patterns of daylight and the level of acuity reduction on the visibility of steps and ramps.

Methods: An indoor space was simulated with one of five types of target—Step Up, Step Down, Ramp Up, Ramp Down and Flat Surface, illuminated by directional lighting through a window at different times of a day from 8AM to 6PM in hourly increments and viewed at two distances: 5 feet and 10 feet. The simulation was rendered using the Radiance software, producing a sequence of photometrically accurate HDR images. These images were then filtered using a linear model (Lei et al., IOVS 2016) to simulate different levels of acuity reduction, ranging from 20/20 (normal) to 20/1280. Normally sighted subjects were asked to identify the target in each image.

Results: The overall responses of the subjects to the five targets closely resembled that of people with low vision making such judgments in a real space (Bochslter et al., IOVS 2013). Confusion between the targets increased with the severity of acuity loss and was most prevalent among Ramp Up, Ramp Down and Flat. Performance was better at the shorter viewing distance, particularly for more severe levels (20/640 and 20/1280) of acuity reduction. Moreover, performance varied as the pattern of daylight changed. A significant interaction (p<0.001) was found between daylight hour and acuity level, so that the variation was more pronounced as acuity loss became more severe. The three-way interaction (p<0.001) between these two factors and target type indicated that the combined effect of daylight pattern and acuity reduction was target-specific.

Conclusions: Our results suggest that variations of natural lighting throughout a day can significantly affect the visibility of key navigational features like steps and ramps, and the adverse effect of lighting gets worse with more severe acuity loss. This finding has important implications for low vision mobility training and architectural design of indoor spaces.

Commercial Relationships: Quan-Lei, None; Brent S. Carpenter, None; Robert Shakespeare, None; Daniel Kersten, None; Gordon E. Legge, None

Support: NIH Grant EY017835

Program Number: 4701 Poster Board Number: B0653
Presentation Time: 11:00 AM–12:45 PM

Reading Performance in Intermediate Age-related Macular Degeneration: Context Effects

Lori A. Lott1, Marilyn E. Schneck1, Gunilla Haegerstrom-Portny2, Susan Hewlett1, John A. Brabyn1, Smith-Kettlewell, San Francisco, CA; 2School of Optometry, UC Berkeley, Berkeley, CA.

Purpose: Our previous study of vision function in intermediate age-related macular degeneration (I-AMD) showed no significant difference in reading performance between I-AMD and age-matched control eyes (C) (Lott et al, ARVO 2016). Reading was tested monocularly using the International Reading Speed Test (IReST), which consists of paragraphs of meaningful text. The purpose of this study is to assess binocular reading in tests with and without context (IReST vs. Pepper Visual Skills for Reading Test: random letters and words [Pepper]). We hypothesize that reading performance for I-AMD will be poorer than C for the Pepper test, due to a lack of context, which places increased demand on vision.

Methods: Sixteen people with I-AMD (mean age =76.1 yrs), and 13 C individuals (mean age =74.7 yrs) participated. All had binocular acuity better than 20/32 (≤0.20 logMAR). The IReST and Pepper rates (correct words per minute [wpm]) were the dependent variables. Vision function (SKILL Card: near high contrast acuity [SKL] and the impact of low luminance and contrast on acuity [SKILL Score; SKDark–SKL]), cognitive status (Montreal Cognitive Assessment: MOCA), speech production rate (letters per second for reciting the alphabet), demographic information, and cataract status were the independent variables.

Results: Binocularly measured IReST reading rates were similar for the I-AMD and C groups (mean =186.6 vs. 190.9 wpm, respectively). However, Pepper rates were significantly lower in I-AMD than C (mean =93.2 vs. 104.4 wpm). The groups did not differ in SKL, age, sex or MOCA. SKILL score was significantly different for the two groups (0.63 vs 0.54 log units), and speech production rate was higher in I-AMD (4.1 vs. 3.3 letters per second). The prevalence of cataract surgery was also higher in the I-AMD group (56.3% vs. 15.4%). Separate linear regression analyses predicting IReST and Pepper from the independent variables confirmed these findings. For IReST, only speech production was a significant predictor of reading. For Pepper, SKILL Score, speech production and AMD category were significant predictors (p<0.001).

Conclusions: In agreement with our previous research using monocular testing, I-AMD and C read at similar rates using meaningful text, but without context, those with I-AMD are at a greater disadvantage. Of particular note is the dramatic difference in cataract surgery rates between the two subject groups.
Commercial Relationships: Lori A. Lott, None; Marilyn E. Schneck, None; Gunilla Haegerstrom-Portnoy, None; Susan Hewlett, None; John A. Brabyn, None
Support: NIH Grant EY023320, NIDILRR Grant 90RE5008

Program Number: 4702 Poster Board Number: B0654
Presentation Time: 11:00 AM–12:45 PM

Predictors of sensitivity to perceptual learning in children with infantile nystagmus
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Purpose: We recently developed a perceptual learning paradigm, based on near-acuity letter and visuomotor training, for 6-11 year old children with infantile nystagmus (IN). This computerized training improved crowded and uncrowded visual acuity, stereopsis and reading but not fixation stability, saccade behaviour and nystagmus properties. This suggests that the vision improvements were primarily due to improved sensory processing rather than improved oculomotor behavior. However, not all children benefitted equally. Here we evaluate if this inter-individual variability can be explained by baseline acuity, diagnosis, age, training condition, and training joy.

Methods: 36 children with IN (idiopathic IN: n=18; oculocutaneous albinism: n=18) were divided into a crowded (n=18) and an uncrowded training group (n=18) matched on age and diagnosis. Training consisted of 10 sessions spread over 5 weeks (3500 trials total). To test whether their effect was related to training, we asked them to rate training joy on a five-point smiley scale. Before and after training, a computerized single- and a crowded-letter discrimination task were presented. Baseline performance, age, diagnosis, training condition and training joy were entered as regression predictors of training-induced changes.

Results: 58% of the variance in single-letter acuity improvements was explained by baseline performance, age, diagnosis, training condition and training joy (F(7,24)=4.67, p<0.002). Age had a positive effect on training outcome (partial r=0.55); older children showed larger gains. Training joy had a positive impact in the uncrowded (partial r=0.67), but not in the crowded training group. 56% of the variance in improvements on the crowded letter task was accounted for by baseline performance, age, diagnosis and training condition (F(7,26)=4.70, p<0.002). Children with idiopathic IN showed larger improvements than children with albinism. Training gains were positively related to initial performance in children with idiopathic IN (partial r=0.76), but not in children with albinism.

Conclusions: Our study is the first to demonstrate that baseline performance, age, diagnosis, training joy and training condition affect perceptual learning in children with IN. These results have practical implications, e.g., to include the child’s perspective on the training as a screening tool to select candidates in whom training will likely result in good outcomes.

Commercial Relationships: Jeroen Goossens, None; F. N. Boonstra, None; Bianca Huurneman, None
Support: This research was supported by: ODAS and LSBS that contributed through UitZicht, Bartimeus Soneheerdt and the Radboudumc

Clinical Trial: NTR2537

Program Number: 4703 Poster Board Number: B0655
Presentation Time: 11:00 AM–12:45 PM

Preliminary evaluation of MP-3 rehabilitation tool
Filippo Maria M. Amore, Valeria Silvestri, Marco Sulfaro, Margherita Guidobaldi, Francesca De Rossi. National Centre of Services and Research for the Prevention of Blindness and Rehabilitation of Low Vision Patients, Rome, Italy.

Purpose: The Nidek MP-3 microperimeter incorporates automatic features as retina alignment and position check. Moreover, MP-3 is going to be implemented with a biofeedback tool characterized by customizable tunes as acoustic signals. The aim of this preliminary evaluation was to compare the biofeedback (BFB) stimulation tool of MP-1 with that of MP-3 with regard to the ratio between the tracked time and the elapsed time as an efficiency indicator.

Methods: A total of 5 patients with central scotoma and instability of fixation referred to National Centre of Services and Research for the Prevention of Blindness and Rehabilitation of Low Vision Patients were included in the observational study. The whole sample attended the structured stimulus BFB both at MP-1 and at MP-3. Patients underwent two consecutive BFB stimulation sessions during the two weeks in which MP-3 prototype was used. In this prospective observational study the BFB elapsed time, indicating the total duration of the session, and the tracked time, indicating the continuous stimulation duration, were examined for the two microperimeters. These data were automatically provided by the MP-1 and MP-3 software.

Results: Nine eyes of five patients were tested. In MP-1 the mean value of the elapsed time was 11.1±1.2 minutes while in MP-3 it was 9.5±2.3 minutes. The mean value of tracked time was 9.9±0.7 minutes in MP-1 while 8.6±2.1 minutes in MP-3. The efficiency index (i.e., the ratio between tracked and elapsed time) was 90%±9% for MP-1 and 91%±5% for MP-3.

Conclusions: MP-3 automatic features seem to be valid tools to control ocular movements in order to continuously verify the retinal alignment and fixation behavior. From these preliminary data, it seems that there is not significant difference between the efficiency indexes of the two microperimeters. Moreover, patients reported to appreciate the customizable acoustic tones. More data is under collection to overcome the limit of the current dataset and provide statistical significant results.

Commercial Relationships: Filippo Maria M. Amore, None; Valeria Silvestri, None; Marco Sulfaro, None; Margherita Guidobaldi, None; Francesca De Rossi, None

Program Number: 4704 Poster Board Number: B0656
Presentation Time: 11:00 AM–12:45 PM

Novel Display Modalities of Visual Field Loss Progression Over Time for Threshold Amsler Grid Tests
Wolfgang Fink1,2, John Cervin1, Chris Adams2. 1Vis & Autonomous Explorat’n Sys, University of Arizona, Tucson, AZ; 2Ceeable Technologies Inc., Somerville, MA.

Purpose: To provide novel display modalities of visual field loss progression over time as a function of Amsler grid contrast for threshold Amsler grid tests when performing subsequent repeat exams of subjects.

Methods: Employing the Ceeable Visual Field Analyzer (CVFA), f.k.a. 3D Computer-automated Threshold Amsler Grid (3D-CTAG, Fink & Sadan, JBO 2004), visual field loss is recorded as missing areas on Amsler grids of various contrast levels.

Results: Two display modalities were devised. Display modality #1 (Fig. 1, top) displays the respective percentage of visual field area not seen as a color-coded (according to Amsler grid contrast levels tested, Fig. 2) horizontal bar of a length proportional to that percentage.

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This modality displays as many color-coded bars as there are contrast levels tested in a CVFA exam. A normal visual field is displayed as a single vertical line of no width. Absolute scotomas are represented as horizontal bars of equal length. Hence a time progression over subsequent exams will always exhibit horizontal bars of equal length if the absolute scotoma character is preserved. The overall magnitude can change, e.g., due to disease or treatment. Relative scotomas are presented as horizontal bars of differing length, i.e., the length is proportional to the respective percentage of vision loss. Hence a time progression of subsequent exams will always exhibit horizontal bars of differing lengths.

Conclusions: Both display modalities are intuitive. Display modality #2, while simpler, requires the added information of tested contrast levels, whereas modality #1 has this information already color-encoded. Both modalities express visual field changes over time due to disease or treatment.

Visual Field Loss Progression over Time: Display Modality #1

| Normal VF: | 
| Absolute Scotoma: | 
| Exam (f): | 
| Relative Scotoma: | 
| Exam (f): | 

Visual Field Loss Progression over Time: Display Modality #2

| Normal VF: | 
| Absolute Scotoma: | 
| Exam (f): | 
| Relative Scotoma: | 
| Exam (f): | 

Color Coding used for Percent Contrast Sensitivity Loss

| 0% | 6% | 10% | 15% | 20% | 25% |
| 30% | 35% | 40% | 45% | 50% | 55% |
| 60% | 65% | 70% | 75% | 80% | 85% |
| 90% | 95% | 100% |

Commercial Relationships: Wolfgang Fink, Ceeable Technologies Inc. (E), Ceeable Technologies Inc. (I), Ceeable Technologies Inc. (P), Ceeable Technologies Inc. (S); John Cerwin, Ceeable Technologies Inc. (E), Ceeable Technologies Inc. (I), Ceeable Technologies Inc. (P), Ceeable Technologies Inc. (S); Chris Adams, Ceeable Technologies Inc. (E), Ceeable Technologies Inc. (I), Ceeable Technologies Inc. (P), Ceeable Technologies Inc. (S)

Program Number: 4705 Poster Board Number: B0657
Presentation Time: 11:00 AM–12:45 PM

Translating visual field changes detected with stimuli within and outside complete spatial summation to optical coherence tomography findings in age-related macular degeneration

Agnes Yiu Jeung Choi, Lisa Nivison-Smith, Sieu Khuu, Barbara Zangerl, Nagi Assaad, Michael Kalloniatis

Centre for Eye Health, The University of New South Wales, Kensington, NSW, Australia; Department of Ophthalmology, Prince of Wales Hospital, Randwick, NSW, Australia.

Purpose: Previous work has shown that visual field (VF) test stimuli operating within complete spatial summation within the central VF reveal more functional loss in patients with ocular disease including age-related macular degeneration (AMD). We investigated whether differences in functional changes detected with different size stimuli translate to structural changes on spectral-domain optical coherence tomography (SD-OCT).

Methods: We measured VF thresholds of 1 eye from patients with intermediate AMD (n=7) and early AMD (n=1) (range: 56-80 years; mean: 70±8 years) using the Humphrey Visual Field Analyzer (HVFA) 10-2 full threshold paradigm with GI to GIII. Test locations with threshold values outside the 95% distribution compared to our normative database were flagged as VF events. SD-OCT imaging (Heidelberg Engineering) of the posterior pole was acquired for all 8 patients and each VF event mapped to a corresponding 287x287μm retinal area. Structural events were defined as an AMD-related abnormality of at least 50% being within the OCT window and summed up for each stimulus within each patient. VF events that corresponded to structural events were counted and expressed as a percentage of the total number of VF events known as the match rate.

Results: Half of the patients scored higher (i.e. greater number of structural events) and 1 patient scored lower for stimuli within complete spatial summation than with GIII. Of these patients that scored higher, half also demonstrated a higher match rate (i.e. greater number of VF events that corresponded to structural events) for stimuli within complete spatial summation compared to GIII.

Conclusions: Visual field events detected by stimuli within complete spatial summation translated to AMD-related abnormalities on OCT more frequently than with GIII, which suggests that such stimuli may be more appropriate for the 10-2 paradigm in patients with intermediate AMD.

Commercial Relationships: Agnes Yiu Jeung Choi; Lisa Nivison-Smith, None; Sieu Khuu, 2014/094035 A1 (USA) (P), 13865419.9 (EU) (P); Barbara Zangerl, None; Nagi Assaad, None; Michael Kalloniatis, 2014/094035 A1 (USA) (P), 13865419.9 (EU) (P)

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**Purpose:** The quality of macular vision can be measured by threshold Amsler grid testing. Measuring changes in macular deficit can be used as a screening test for patients with early Exudative ARMD as well as a biomarker for quantifying visual improvement after treatment for Exudative ARMD by anti-VEGF drugs.

**Methods:** Baseline VA (Snellen), OCT, IVFA/ICG, and OCT Angiography (OCTA) was obtained on 30 eyes in 25 patients with Exudative ARMD. Baseline quantification of central field abnormalities was obtained with the Ceeable Visual Field Analyzer (CVFA, f.k.a. 3D-CTAG: Fink and Sadun, JBO 2004): an Internet-based 3D threshold Amsler grid test. 10 patients with subthreshold Exudative ARMD were followed longitudinally as a screening tool. 15 patients with threshold Exudative ARMD had CVFA testing performed on the day of the first treatment and on all subsequent examinations. Patients were treated with one of two intravitreal anti-VEGF agents (ranibizumab and aflibercept). Each CVFA test measured the following quantifiable variables: Lost Area Grade (LAG= scotoma area ratio as a function of contrast sensitivity), Preserved Area Grade (PAG = intact visual field area ratio as a function of contrast sensitivity), and Hill-of-Vision Volume Loss (HVL= ratio of not seen versus total number of Amsler grid points).

**Results:** 2 out of 10 patients with sub-threshold Exudative ARMD exhibited Amserl grid changes on the CVFA that correlated with OCT and/or OCTA changes and represented a threshold for treatment. All 15 treatment patients had macular deficits that showed prominent central defects that correlated to the degree and location of exudation and vision loss. Several patients with varying vision but similar Snellen visual acuity demonstrated different levels of macular deficits on CVFA testing. Most important was the measurable improvement of macular structure and function after standard treatment of exudation.

**Conclusions:** Ceeable Visual Field Analyzer is a direct, non-invasive, sensitive, and easy-to-use functional retinal imaging technology which may prove to be useful as a screening tool, but most importantly, as a biomarker to measure visual rehabilitation following anti-VEGF treatment.

**Commercial Relationships:** Mark H. Nelson, Ceeable (C), Optos (C), Thrombogenics (C), Heidelberg Engineering (C); Wolfgang Fink, Ceeable, Inc (S), Ceeable, Inc (I), Ceeable, Inc. (E), Caltech (P); Chris Adams, Ceeable, Inc. (S), Ceeable, Inc (E), Ceeable, Inc (I); John Cerwin, Ceeable, Inc. (S), Ceeable, Inc (E), Ceeable, Inc (I)

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**Program Number:** 4707 Poster Board Number: B0659
**Presentation Time:** 11:00 AM–12:45 PM
**The correlation between visual function and morphologic changes in retinal vein occlusion**

**Purpose:** To estimate the correlation between visual function and retinal morphologic changes in retinal vein occlusion (RVO).

**Methods:** 17 eyes of 17 patients with macular edema secondary to RVO were enrolled in the current study and were injected with anti-VEGF agents. Before and after the treatment, central retinal thickness (CRT) and macular volume of the central 2 mm circle (MV) were measured, using spectral-domain optical coherence tomography (SD-OCT) as retinal morphologic parameters. The best-corrected visual acuity (BCVA) and the mean retinal sensitivity of the 9 measured points in the central 4-degrees (MRS) were evaluated as visual functions. The MRS was measured with the microperimetry (MP-3, Nidek). We investigated the correlation between visual functions and retinal morphologic parameters, using multivariate regression analyses.

**Results:** Mean age of participants was 72.35±6.13 years. All 17 eyes of 17 patients gained the dry retinas after anti-VEGF treatments. The MRS showed a significant improvement from baseline after the treatment (baseline vs post; 19.56±5.18 vs 21.19±4.90 dB, p=0.032). However, mean BCVA did not show a significant improvement. (baseline vs post; 0.29±0.34 vs 0.21±0.25, p=0.14).

Multivariate regression analysis showed that the preoperative MRS was adopted as an explanatory variable for preoperative BCVA (AIC=2.76). When the preoperative MV was selected as a response variable, the preoperative MRS was adopted as the explanatory variable (AIC=8.57). The changes of MRS were significantly correlated with those of MV (p=0.026). However, there was no significant correlation between MRS and CRT changes.

**Conclusions:** The present study showed that the retinal sensitivity may be effective as the parameter which is associated with retinal morphologic changes after the anti-VEGF treatment for RVO.

**Commercial Relationships:** RYOSUKE FUJINO, Tatsuya Inoue, None; Keiko Azuma, None; Hiroshi Murata, None; Ryo Asooka, None; Ryo Obata, None

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**Program Number:** 4706 Poster Board Number: B0660
**Presentation Time:** 11:00 AM–12:45 PM
**Vision function differs with retinal characteristics in AMD: large drusen with and without pigment abnormalities**

**Purpose:** Drusen size and pigmentary changes are factors related to the risk of development of advanced AMD. Our goal was to determine whether vision function is related to the presence of pigment abnormalities in eyes with large drusen.

**Methods:** Best-corrected vision was measured in each eye in individuals diagnosed with early to intermediate AMD as part of a larger study (Lott et al, ARVO 2016). Data from 39 individuals (dominant eye at near) with multiple large drusen (≥125 microns) in the central 10 degrees of the macula are included. Two subgroups were formed on the basis of the presence (LDwP group, n=16) or absence (LDonly group, n=23) of accompanying pigment abnormalities (mean age 77.9±10.5 and 74.7±11.2 years, respectively). Vision measures included high contrast visual acuity (HCVA, SKILL light chart), low contrast low luminance acuity (SKILL Dark chart), contrast sensitivity (MARS chart), color vision (Adams desaturated D-15 color arrangement test), and shape discrimination hyperacuity (SDH- threshold for the identification of a distorted circle from among 3 circles; Wang et al., IOVS, 2013). SKILL score (the difference between logMAR acuity on the light and dark charts of the SKILL Card) was calculated. One-tailed t-tests were used to determine whether vision function is poorer in eyes with large drusen and pigment abnormalities than in eyes with large drusen alone. With Bonferroni correction, p<0.01 is statistically significant.

**Results:** Mean HCVA was fairly good and did not differ between groups (logMAR = 0.10 or 0.20 for both). MARS log contrast...
sensitivity was also very similar between the LDwP and LDonly groups (1.59±1.62; p=0.18). SKILL score (0.64 vs. 0.57, p=0.045) and color confusion score (62.4 vs. 43.1, p=0.10) were both similarly, but not significantly, poorer in eyes with pigment abnormalities. Only SDH differed significantly between groups (-0.44 vs -0.61, p=0.007), with higher thresholds in the group with pigment abnormalities than those with large drusen only.

Conclusions: Though standard visual acuity does not distinguish groups with different risk characteristics for developing advanced AMD, in eyes with large drusen, shape discrimination hyperacuity thresholds are further elevated in the presence of pigment abnormalities.

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

Support: NIH Grant EY023320

Program Number: 4709 Poster Board Number: B0661
Presentation Time: 11:00 AM–12:45 PM

Correlations of Measurements of Vision with Patient Reported Functional Vision Outcomes

Kevin Marsh1, Stephen H. Sinclair1, Peter Presti2, Walter Gutstein3. 1Ophthalmology, Drexel University College of Medicine, Philadelphia, PA; 2Georgia Institute of Technology, Atlanta, GA; 3University of Vienna, Vienna, Austria.

Purpose: Visual acuity recorded with photopic standard black letter charts or contrasted sinusoidal gratings previously have correlated poorly against measures of functional vision such as patient report outcomes in patients with macular disease. The Central Vision Analyzer (CVA) and Omnifield purport to threshold resolution capability at fixation and throughout the central 20-degree diameter visual field under photopic and mesopic conditions mimicking daily encountered tasks.

Methods: A retrospective study was conducted in 190 patients with ARMD of varying severity without comorbidities, analyzing the correlation of NEI VFQ-25 patient reported functional vision assessments with habitual spectacle acuity, measured with the ETDRS chart, CVA thresholded central acuity under three photopic conditions at 99% (G1), 10% (G2), and 8% MC (G3) and three mesopic at 99% (M1), 65% (M2), and 43% (M3), and Omnifield parameters at 99% MC of central acuity (CA), best acuity at any intercept within 6 degrees(BA6), global macular acuity (GMA), and resolution area and volume field measures ≥20/40, ≥20/80, and ≥20/160. VFQ responses were grouped into four categories evaluating distance and near-vision tasks (DT and NT, respectively) in either well-lit (WL) or dimly-lit (DL) settings and compared (Pearson correlation coefficients) with estimates of binocular vision from the value measured with the better seeing eye and differences between the two eyes. Although correlations were calculated for both DT and NT, the primary focus of this abstract will be DTs.

Results: Visual function for DT/WL tasks correlated with chart acuity with Pearson r=0.49. The Pearson coefficients varied among the CVA (M1-3 and G1-3), ranging from 0.19 to 0.33 as well as the Omnifield parameters, ranging from 0.14 to 0.32. Correlations also varied in DT/DL tasks where the CVA and Omnifield demonstrated Pearson correlations that ranged from 0.14 to 0.38, and 0.21 to 0.27, respectively. This is compared to the Pearson correlation of chart acuity with DT/DL, of 0.52.

Conclusions: The wide disparities of correlations of the various vision measures with VFQ functionality suggest the influence of chronic adaptation that allows persons to manage many vision tasks after prolonged periods even with very poor vision. This indicates the need for VFQ PRO assessments to evaluate the influence of adaptive periods and methods on functionality.

Commercial Relationships: Kevin Marsh; Stephen H. Sinclair, CEO - Sinclair Technologies (S); Peter Presti, Sinclair Technologies (S); Walter Gutstein, None

Program Number: 4710 Poster Board Number: B0662
Presentation Time: 11:00 AM–12:45 PM

Association between visual function and macular pigment optical density (MPOD) in older eyes in normal macular health

Anna V. Zarubina1, Carrie E. Huisingsh1, Mark E. Clark1, Gerald McGwin1, 2, Christine Curcio1, Cynthia Owlesley1. 1Department of Ophthalmology, University of Alabama at Birmingham, Birmingham, AL; 2Department of Epidemiology, School of Public Health, University of Alabama at Birmingham, Birmingham, AL.

Purpose: To examine the association between MPOD and rod- and cone-mediated vision in older adults with healthy maculas.

Methods: Baseline data from the Alabama Study on Early Age-Related Macular Degeneration (ALSTAR) (PMID: 27074381) served as the data source for this cross-sectional analysis. Eyes of participants ≥ 60 years old in normal macular health were included in the analysis. Normal macular health was defined as those eyes at step 1 of the AREDS 9-step classification system based on color fundus photography. MPOD, rod-mediated dark adaptation (RMDA), best-corrected photopic visual acuity, photopic contrast sensitivity, photopic light sensitivity in the macula, mesopic acuity, and low luminance deficit, were assessed. MPOD was estimated at the fovea via heterochromatic flicker photometry. RMDA was estimated using the AdaptDx (PMID: 26522707). Spearman correlation coefficients were used to examine associations between visual function and MPOD. Results were adjusted for age and stratified by gender.

Results: A total of 731 eyes were analyzed. In the overall cohort, MPOD was unrelated to RMDA, photopic acuity and contrast sensitivity, mesopic acuity, and low luminance deficit. Greater MPOD was associated with better macular light sensitivity (average of 16 points in central 9° of macula), rho = 0.100, age-adjusted, p = 0.007. When stratified by gender, this correlation was 0.131 among females (n = 495; age-adjusted, p = 0.0035) and 0.033 among males (n = 234; age-adjusted, p = 0.618).

Conclusions: In a large sample of older adults in normal macular health, MPOD is unrelated to RMDA, contrary to an earlier report on a small sample (PMID: 24413682). However, better cone-mediated light sensitivity in the macula was associated with eyes with greater MPOD, a finding that was limited to females. Other measures of cone-mediated function in the fovea were unrelated to MPOD. The positive relationship of MPOD with cone vision and not rod vision resonates with recent evidence that Müller cells are the major xanthophyll reservoir in human macula, while also providing services like retinoid processing and synaptic insulation to cones exclusively. The gender difference is consistent with evidence for a broader MPOD distribution in women that could affect sensitivity outside the fovea.

Commercial Relationships: Anna V. Zarubina, None; Carrie E. Huisingsh, None; Mark E. Clark, None; Gerald McGwin, None; Christine Curcio, None; Cynthia Owlesley, The University of Alabama at Birmingham (P), Genentech (F)

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Critical Flicker Fusion Scores Across Stimulus Luminance Ranges in Young and Old

Keith J. Lane1, Christian Sundstrom1, Endri Angjeli2, Peter Corcoran1, John D. Rodriguez1, Mark B. Ahelson1, 2, David A. Holland1. 1Clinical R & D, ORA, Andover, MA; 2Ophthalmology, Harvard School of Med, Boston, MA; 3Ora, Inc, Andover, MA.

Purpose: Critical flicker fusion (CFF) is a measure of visual processing speed that has been shown to correlate with age-related changes in visual function (Maier et al, 2010). The relationship between CFF and luminance levels was examined in young and older subjects to determine if age-related deficits in CFF are dependent on luminance level of presented stimuli.

Methods: The Lafayette Instruments flicker fusion system was used to test CFF at ten luminance levels, including photopic (44.88 candela/meter²), mesopic (0.044-0.0022 cd/m²) and scotopic (0.0022-0.00022 cd/m²) light levels. A staircase protocol employed increasing and decreasing luminance CFF tests, with average values calculated at each level. Both eyes were included in testing. A 45-minute dark adaptation was performed for the scotopic and lowest two mesopic levels. Subjects (n=18) were selected to provide representation of a range of ages; analysis was based on 2 age groups, < 70 years (n=9, mean age 42.2) and ≥ 70 years (n=9, mean age 73.2).

Results: The CFF scores for all subjects were directly correlated with the stimulus luminosity. Comparisons of mean CFF for the two age groups exhibited the greatest difference at the brightest photopic luminance levels, but were statistically different at all levels from 44 to 0.044 cd/m² (p-values all ≤ 0.00022). No statistically significant differences were observed between the two age groups in the lower mesopic range.

Conclusions: Greatest differences in CFF between younger and older subjects are observed with stimuli in the photopic and upper mesopic ranges. CFF measured with photopic luminance stimuli may be optimal for testing age-related flicker sensitivity changes.
Commercial Relationships: Keith J. Lane, ora, Inc (E); Christian Sundstrom, Ora, Inc (E); Endri Angjeli, Ora, Inc (E); Peter Corcoran, Ora, Inc (E); John D. Rodriguez, Ora, Inc (E); Mark B. Abelson, Ora, Inc (E), Ora, Inc (P); David A. Hollander, Ora, Inc (E)

Program Number: 4714 Poster Board Number: B0666
Presentation Time: 11:00 AM–12:45 PM

Critical Flicker Fusion Recovery Following Photo-Bleach in Young and Old Subjects

Purpose: Critical flicker fusion (CFF) is a measure of visual processing speed. We examined CFF threshold at specific time-points after photo-bleach in order to assess age-dependent cone recovery over time.

Methods: Photo-bleaching employed a 90-second exposure to a specialized light source delivering 40,000 cd/m². This method was independently confirmed to provide bleaching of >84% of cones. Baseline CFF (repeat testing) was obtained for one eye at 100% device luminance using a mean value derived from both increasing and decreasing frequency staircases. Post-bleach CFF testing was measured at 30 seconds and at 1½, 2½, and 3½ minutes using 2 luminance levels: photopic (44 cd/m²) or mesopic (4.4 cd/m²).

Results: Ten subjects who completed the protocol were grouped into young (mean 24.3), middle (mean 39.8) and old (mean 60.3) cohorts, and mean CFF values were calculated for each group at each time point. CFF measured with photopic luminance showed an age-dependence to recovery, with the older patients exhibiting an 8.9% initial decrease (p=0.017), while subjects in the youngest cohort decreased by 4.3% (p=0.136). All subjects returned to baseline within 150 seconds, and all groups exhibited a characteristic overshoot in which CFF threshold was increased relative to baseline. For mesopic testing, younger patients showed the largest decrease in CFF following photobleach (13.5%, p=0.001). At the lower luminance, there was a sustained decrease in CFF.

Conclusions: Recovery of CFF after photobleach appears to be age-dependent. Under photopic luminance, older individuals exhibit a greater change and longer recovery time. At lower, mesopic luminance, older subjects show a lesser effect on thresholds, although recovery times are similar for all ages.

Commercial Relationships: Christian Sundstrom, Ora, Inc (E); Endri Angjeli, Ora, Inc (E); John D. Rodriguez, Ora, Inc (E); Peter Corcoran, Ora, Inc (E); Keith J. Lane, Ora, Inc (E); Mark B. Abelson, Ora, Inc (E), Ora, Inc (P); David A. Hollander, Ora, Inc (E)

Program Number: 4715 Poster Board Number: B0667
Presentation Time: 11:00 AM–12:45 PM

Photostress Recovery: A comparison of bleaching methods for surrogate maculopathy endpoints

Purpose: Photostress and photobleach have been studied as potential endpoints for evaluating novel therapeutics for maculopathies. Key to an effective endpoint is the ability to clearly distinguish study populations. The OraLux System and the Eger Macular Stressometer were compared to determine their relative ability to distinguish potential age differences in recovery of best corrected visual acuity (BCVA) after photobleach in a normal population.

Methods: A group of 8 normal subjects (mean age 39.3 ± 16) (16 eyes) were subjected to macular photostress using the Eger Macular Stressometer and the OraLux System. Photobleach using the Stressometer was by means of a thyristor photo flash held at a distance of 6 inches. The OraLux System provided a diffuse light source of 40,000 cd/m² viewed for 90 seconds from a distance of 12 inches (~84% cone photopigment bleach). Bleaching was performed in random order. At least 30 minutes were allowed for recovery from the OraLux bleach, and 10 minutes for the Stressometer, per protocol for that device. After photobleaching by each method, subjects were instructed to read an eye chart at 40 cm under two ambient light levels: 700 lux and 90 lux. The recovery time needed to read one line above BCVA was measured.

Results: Mean VA recovery time (seconds) for the OraLux System increased with subject age (sec/year) at (1.24 OD, p=0.001; 1.07 OS, p=0.025) at 90 lux and (0.39 OD, p=0.45; 0.42 OS, p=0.26) at 700 lux. Mean recovery time at 90 lux was significantly greater for subjects over 40 years (98.2 sec) than for younger (61.4 sec) p=0.02. Mean VA recovery time (seconds) for the Stressometer did not trend consistently with subject age (-0.17 OD, p=0.31; -0.24 OS, p=0.094) at 90 lux and (-0.029 OD, p=0.26; 0.105 OS, p=0.22) at 700 lux. No mean comparisons were significant (p=0.11).

Conclusions: The OraLux System showed a consistently better correlation than the Eger Macular Stressometer with regard to recovery of visual acuity and age over a range of ambient light levels, possibly due to a greater impact on cones during photostress. This system offers a potential new instrument for studying maculopathies and differentiating the impact of therapies in future clinical trials.

Commercial Relationships: John D. Rodriguez, Ora, Inc (E); Keith J. Lane, Ora, Inc (E); David A. Hollander, Ora, Inc (E)
Purpose: Vehicle driving is a complex task involving multiple cognitive processes such as visuo-spatial skills and attentional processes. Accordingly, simple measures of vehicle maneuvering might be dependent on the visual attentional load and cannot be sufficient by themselves to faithfully evaluate hazardous driving behavior. This study examined which of the experimental measures, visual attentional load or perceptual-cognitive functions, revealed differences in driving abilities.

Methods: A total of 115 licensed drivers between the ages of 18 and 86 performed three simulator scenarios each meant to represent ecological driving environments with an increasing visual attentional load: highway (i.e. low), rural (i.e. middle) and city (i.e. high). Through partial correlations and ANCOVA controlling for mean speed, we assessed the reliability of 22 driving measures to capture the reaction from participants when facing dangerous events. Additionally, we used an independent task known as 3-Dimensional Multiple Object Tracking (3D-MOT) to assess the participants’ ability to simultaneously track and maintain their attention on multiple moving objects.

Results: The rural scenario, designed as a middle ground in terms of visual attentional load, ultimately lead to be the most efficient across age. For instance, the well-known propensity of older adults to have more crashes when facing unexpected events was evidenced only in this scenario ($F(1,112)=3.55; p=.03$). Importantly, our perceptual-cognitive measure (3DMOT) was relevant as it was strongly correlated with the mean speed naturally adopted by the participants ($r(113)=-.54, p<.001$). This result indicates that more the perceptual-cognitive abilities were altered, more driving speed was decreased.

Conclusions: Our results demonstrate that subtle differences in driving abilities were better captured when attentional load was moderate enough to challenge but did not overwhelm the participants. They also suggest the usefulness of using perceptual-cognitive measures in driving simulator studies. We propose that such a measure could be informative, not just to assess perceptual and cognitive differences between age-groups, but also to determine the influence of subtle changes in cognition on driving behaviours.

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Scenarios and measures to faithfully evaluate hazardous driving behavior: new insights on the usefulness of using perceptual-cognitive measures
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Purpose: To describe the visual impairment associated with ocular and neurological abnormalities in a cohort of children with congenital Zika syndrome (CZS).

Methods: This prospective cross-sectional study included infants with microcephaly born in Pernambuco, Brazil, May to December 2015. Immunoglobulin M antibody capture enzyme-linked immunosorbent assay for the Zika virus (ZIKV) on the cerebrospinal fluid (CSF) samples was positive for all infants. Clinical evaluation consisted of comprehensive ophthalmologic examination including functional vision assessment, neurologic and neuroimaging.

Results: Thirty-two infants (mean age at exam $5.7 \pm 0.9$ months [range, 4.5 to 7.4 months]) were included in the study, from which 18 were male (56.3%). Visual function could not be tested in one (3.1%) of the 32 infants. Visual impairment, including nonattainment of visual milestones, was detected in 30 of the 31 infants (96.8%). Ocular findings were observed in 14 patients (43.8%). All patients (100%) demonstrated neurological and neuroimaging abnormalities, of which four (12.5%) did not present microcephaly at birth, only later.

Conclusions: Most children with CZS demonstrated severe visual impairment. More than half presented cerebral visual impairment, characterized by visual impairment as a consequence of the neurological involvement, regardless of ocular findings.