

**266 Spatial and Temporal Vision, Function and Task Performance in Aging and Low Vision**

**Monday, May 2, 2011, 1:45 PM - 3:30 PM**

Hall B/C Poster Session

**Program #/Board # Range:** 1878-1922/D836-D880

**Organizing Section:** Visual Psychophysics/Physiological Optics

**Contributing Section(s):** Retina+

**Program Number:** 1878 **Poster Board Number:** D836

**Presentation Time:** 1:45 PM - 3:30 PM

**Poor Correlation between Different Putative Measures of Magnocellular Function**

*Patrick T. Goodbourn<sup>1</sup>, Jenny M. Bosten<sup>1,2</sup>, Ruth E. Hogg<sup>1,3</sup>, Gary Bargary<sup>1</sup>, Adam J. Lawrence-Owen<sup>1</sup>, J. D. Mollon<sup>1</sup>.* <sup>1</sup>Department of Experimental Psychology, University of Cambridge, Cambridge, United Kingdom; <sup>2</sup>Department of Psychology, University of California, San Diego, CA; <sup>3</sup>Centre for Vision Science and Vascular Biology, Queen's University, Belfast, United Kingdom.

**Purpose:** Deficits of rapid temporal processing have frequently been associated with certain cognitive disorders, particularly developmental dyslexia, autism and schizophrenia. Several theorists have proposed that these findings reflect a generalised deficit affecting the visual magnocellular system as well as its auditory homologue. However, it is unclear whether performance on the various psychophysical tasks intended to probe magnocellular function is actually supported by a common substrate. To investigate this question, we asked whether different putative tests of magnocellular function correlate across participants.

**Methods:** As part of the PERGENIC project, 1064 participants completed four putative tests of magnocellular function: detection of Gabors of low spatial and high temporal frequency (GS); detection of pulsed gratings on a steady luminance pedestal (SP); detection of coherent motion (CM); and discrimination of auditory temporal order (TO). We calculated correlations between these measures within our sample, as well as test-retest reliabilities based on a randomly selected subsample of 105 participants.

**Results:** All measures showed good test-retest reliability, ranging from  $\rho = .52$  (SP) to  $.77$  (TO). However, only the correlation between the two most similar tasks (GS-SP) was of notable magnitude ( $\rho = .38$ ). Most intercorrelations between other measures were significant, but effect sizes were poor to modest, ranging from  $.06$  (FD-TO) to  $.20$  (SP-TO).

**Conclusions:** Our results suggest that—with the exception of GS and SP—very little of the variance in performance on each of the tests is mediated by a common substrate. We discuss the implications of our findings for magnocellular theories of cognitive disorder.

**Commercial Relationships:** Patrick T. Goodbourn, None; Jenny M. Bosten, None; Ruth E. Hogg, None; Gary Bargary, None; Adam J. Lawrence-Owen, None; J. D. Mollon, None

**Support:** Gatsby Charitable Foundation

**Program Number:** 1879 **Poster Board Number:** D837

**Presentation Time:** 1:45 PM - 3:30 PM

**Updating the Standard Spatial Observer for contrast detection**

*Albert J. Ahumada, Jr., Andrew B. Watson.* NASA Ames Research Center, Moffett Field, CA.

**Purpose:** The ModelFest data to has been used construct a Standard Spatial Observer model for small target contrast detection. The model has three steps: the contrast image 1) is filtered by a contrast sensitivity function (CSF) including an oblique effect, 2) is windowed by a Gaussian aperture to represent the higher sensitivity of the fovea, 3) is summed over space with a summation exponent near 2.5. The model fit the data from 16 observers for 43 stimuli with an RMS error of 1.0 dB. Since the observer x image interaction error was 0.6 dB, the authors concluded that significant improvement in the model was still possible.

**Methods:** Additional fitting was done with modifications to the model or data.

**Results:** 1) Two of the stimuli were excluded: the noise sample and the San Francisco scene. These two stimuli have much more entropy, which strongly reduces detectability. Absent those two stimuli, the RMS drops to 0.7 dB, and the benefit of the oblique effect is negligible.

2) On the large Gabors all 16 observers detected the large Gabor at 4 cpd better than at 3 or 5.6 cpd. Nine of the 41 images are 4 cpd Gabors. The hypothesis that these 9 could be fit by the same CSF as the rest was statistically rejected. The next most frequent pattern has only 4 images, so this effect is likely to be an artifact of perceptual learning. With this effect included, the fit of the model is lowered to less than 0.6 dB, the level of the observer by image interaction.

3) Previously estimated Gaussian window functions ranged in SD from 0.35 to 0.5 deg, predicting negligible sensitivity in the parafovea. Assuming each cone contributes a constant amount of noise, the contrast sensitivity will be proportional to the square root of the cone density or directly proportional to the estimated Nyquist frequency. Fitting the human cone density measurements of Curcio, et al. (1992 J Comp. Neurol.), we obtain a windowing function with no free parameters that maintains peripheral sensitivity and fits the ModelFest data as well as the Gaussian window.

**Conclusions:** A simpler, more plausible version of the Spatial Standard Observer

model accounts for essentially all the predictable variation in the 16 observer by 41 image ModelFest data.

**Commercial Relationships:** Albert J. Ahumada, Jr., None; Andrew B. Watson, 7783130 B2 (P)

**Support:** NASA Space Human Factors Engineering Project

**Program Number:** 1880 **Poster Board Number:** D838

**Presentation Time:** 1:45 PM - 3:30 PM

**The Effects Of Aging On Shape Discrimination: Closed Contours, And Textured Shapes Within Noise**

*Allison M. McKendrick, Anne E. Weymouth.* Optometry & Vision Sciences, University of Melbourne, Carlton, Australia.

**Purpose:** Previous reports suggest that aging minimally alters global closed shape discrimination. However, it has also been reported that older adults have more difficulty on tasks embedded in noise, including the extraction of contours such as required for global shape perception. In this study, we compare the effects of aging on two intermediate shape discrimination tasks: a global closed shape task (radial frequency (RF) patterns) and a glass pattern coherence task (discrimination of global shape signal from noise). Cortical area V4 is considered a key processing region for both stimuli, however, the mechanisms involved in the processing of these stimuli are likely to serve different purposes in normal vision. We predicted that the extraction of shape information from noise (Glass patterns) would not be robust to aging.

**Methods:** Fourteen younger (19-38 years, mean = 27) and 14 older (62-72 years, mean = 66) adults participated. Contrast detection thresholds were measured for the RF and Glass stimuli. Stimuli were then presented at 5 x contrast threshold for each participant for the shape discrimination tasks. A single-interval forced choice method of constant stimuli was used. For the RF task, the threshold sinusoidal amplitude for the discrimination of an RF3 (triangular) versus an RF4 (square) was measured. For the Glass pattern task, the threshold signal coherence level for the discrimination of concentric from radial patterns was determined.

**Results:** Aging reduced performance on both shape discrimination tasks: RF: mean older = 27 sec arc, younger = 18 sec arc,  $t(26) = -3.14$ ,  $p < 0.01$ ; Glass patterns: mean older = 29% coherence, younger = 16% coherence,  $t(26) = -5.67$ ,  $p < 0.01$ . To compare the magnitude of effect between tasks, effect sizes (Cohen's d) were calculated as 2.1 for Glass patterns and 1.2 for RF patterns, demonstrating a relatively greater drop in performance for the glass pattern task with age.

**Conclusions:** Shape perception is not robust to the effects of aging. Greater deficits were manifest for the discrimination of shape from texture, than for the discrimination of closed contours. The data supports the premise that older adults have exacerbated difficulty on visual tasks that require extraction of signal from noise.

**Commercial Relationships:** Allison M. McKendrick, None; Anne E. Weymouth, None

**Support:** ARC DP0877923, ARC FT0990930

**Program Number:** 1881 **Poster Board Number:** D839

**Presentation Time:** 1:45 PM - 3:30 PM

**Older Adults Show Both Apparent Increased And Decreased Perceptual Surround Suppression Depending On The Task**

*Renee Karas, Allison M. McKendrick.* Optometry and Vision sciences, The University of Melbourne, Carlton, Australia.

**Purpose:** The contrast appearance of a central grating patch is reduced in the presence of a high contrast annulus of similar grating, which is thought to reflect centre-surround visual processing. Older adults show an increased magnitude of such suppression (Karas & McKendrick, 2009). However, it has also been shown that older adults can determine the direction of motion of a large high contrast drifting grating in shorter presentation times than younger adults (Betts et al., 2005), suggested to be due to a reduction in cortical inhibitory function. The purpose of our study was to compare surround suppression measures for a drifting version of the perceived contrast centre-surround task, in addition to the motion direction task, in an attempt to clarify the effects of aging on different measures of surround suppression.

**Methods:** Fourteen younger (19-34 years, mean = 25) and 10 older (61 to 75, mean = 69) adults completed two tasks: 1) a contrast discrimination task which measured the point of subjective equality (PSE) for a central patch of drifting sinusoidal grating (0.67 deg, 2c/deg, 2deg/sec, 40% contrast) with and without an annular surround (4 deg, 95% contrast); and 2) a motion direction discrimination task (gabor: 1c/deg, 2deg/sec, 92% contrast) which measured the duration threshold (stimulus presentation duration needed to correctly identify the direction of motion) for stimulus sizes of  $2\sigma = 0.7, 1.3, 2.7$  and 5 deg, where  $\sigma$  is the standard deviation of the Gaussian envelope.

**Results:** The suppression of perceived contrast due to an annular surround was greater for the older adults than younger adults [ $t(22) = 5.91$ ,  $p < 0.001$ ]. For the motion discrimination task, duration thresholds increased with stimulus size for both younger and older adults. A suppression index (SI) was calculated [ $\log(\text{threshold for the 5 deg stimulus}) - \log(\text{threshold for the 0.7 deg stimulus})$ ] for each individual. There was a trend for a lower SI in older adults that approached statistical significance [ $t(22) = 2.06$ ,  $p = 0.052$ ].

**Conclusions:** Older observers demonstrate increased surround suppression on one

task (contrast discrimination for drifting gratings) while demonstrating apparently decreased surround suppression on the other (motion discrimination task for drifting gratings). These findings do not support a generalised model of reduced cortical inhibition in normal aging, but suggest that other factors such as disrupted signal timing are more likely candidates.

**Commercial Relationships:** Renee Karas, None; Allison M. McKendrick, None  
**Support:** ARC DP0877923, ARC FT0990930

**Program Number:** 1882 **Poster Board Number:** D840

**Presentation Time:** 1:45 PM - 3:30 PM

**Achromatic Discrimination Of Gabor Functions: Space And Spatial Frequency Joint Entropy For The Human Visual System Estimated From Psychometric Functions**

Vladimir A. Silveira<sup>1A</sup>, Givago S. Souza<sup>1A,1B</sup>, Bruno D. Gomes<sup>1B</sup>, Anderson R. Rodrigues<sup>1A</sup>, Luiz Carlos L. Silveira<sup>1A,1B</sup>. <sup>A</sup>Nucleo de Medicina Tropical, <sup>B</sup>Instituto de Ciencias Biologicas, <sup>1</sup>Universidade Federal do Para, Belem, Brazil.

**Purpose:** To estimate space and spatial frequency joint entropy of the human visual system by using psychometric functions obtained from discrimination of black-and-white Gabor functions.

**Methods:** Stimuli were driven by Visage system (CRS). Stimuli were displayed in a CRT monitor (Mitsubishi Diamond Pro 2070SB CRT). Reference stimuli were horizontal, achromatic, stationary sine wave gratings of 0.4 (n = 3), 2 (n = 6), and 10 cpd (n = 3) enveloped by Gaussian functions of 1° standard deviation. The reference stimulus was presented for 1 s, followed by a blank screen with the same mean luminance and chromaticity for 1 s, a test stimulus with different spatial frequency or standard deviation for another 1 s, and again a blank screen with a tone to indicate that the subject had to signal if both stimuli were equal or different by pressing a CB6 Response Box (CRS). We tested 21 different test stimuli around 1° of standard deviation and 19 different test stimuli around the reference spatial frequency (0.4, 2, or 10 cpd) at 100%, 10%, 5%, and 2% Michelson contrasts. Space or spatial frequency entropy were taken as the standard deviations of the Gaussian functions fitted to the data of space or spatial frequency discrimination, and the joint entropy was then estimated by multiplying the spatial frequency entropy by the square root of the space entropy. The results were then compared with the theoretical limit for one dimensional Gabor functions (1/4π) (Daugman *et al.*, 1985).

**Results:** For all spatial frequencies, mean joint entropy decreased as a function of Michelson contrast. *Space 1°, spatial frequency 0.4 cpd:* mean joint entropy reached values below the theoretical limit at 100% contrast. *Space 1°, spatial frequency 2 cpd:* mean joint entropy reached values below the theoretical limit between 5% and 100% contrast. *Space 1°, spatial frequency 10 cpd:* mean joint entropy remained higher than theoretical limit for all contrast conditions.

**Conclusions:** Joint entropy may reach values below the theoretical limit if non-linear interactions between two or more visual pathways, such as the M and P pathways, occur at higher visual system levels (Silveira, 1998; Silveira *et al.*, 2008). This effect may explain the results for high contrasts at intermediate spatial frequencies (2 cpd). For very low or very high spatial frequencies, a single visual pathway may be in charge of measuring luminance contrast.

**Commercial Relationships:** Vladimir A. Silveira, None; Givago S. Souza, None; Bruno D. Gomes, None; Anderson R. Rodrigues, None; Luiz Carlos L. Silveira, None

**Support:** CAPES; CNPq; CNPq-PRONEX / FAPESPA; FINEP IBN Net; LCLS is a CNPq research fellow.

**Program Number:** 1883 **Poster Board Number:** D841

**Presentation Time:** 1:45 PM - 3:30 PM

**Psychophysical Evaluation of Retinal Straylight Among Argentinean Subjects**

Emilia Longhi<sup>1</sup>, Luis Issolio<sup>2</sup>, Elisa Colombo<sup>2</sup>, Dora Fix Ventura<sup>1</sup>, Marcelo Fernandes da Costa<sup>1</sup>. <sup>1</sup>Institute of Psychology, University of Sao Paulo, Sao Paulo, Brazil, <sup>2</sup>Departamento de Luminotecnica, Luz y Vision, Universidad Nacional de Tucumán - ILAV (UNT - CONICET), San Miguel de Tucumán, Argentina.

**Purpose:** To measure retinal straylight in an Argentinean population and to compare it with European norms.

**Methods:** Straylight was assessed using *C-Quant* that uses an adaptive staircase method (Compensation Comparison, Franssen *et al.*, IOVS, 47: 768, 2006). 30 subjects were tested (mean age = 41.39±14.19 yrs). Refractive errors were corrected in the *C-Quant* apparatus, and the subjects could have ocular diseases or vision-threatening conditions (e.g., diabetes, unregulated blood pressure, high intraocular pressure, clinical diagnosis of cataract), but all subjects had 20/20 visual acuity (with correction, if necessary). Only 6 subjects (20%) had lightly-pigmented eyes. Each eye was tested 3 times, yielding 6 straylight values (s) per subject. Only data fulfilling *C-Quant* reliability criteria were included.

**Results:** There were no statistical differences between Argentinean straylight values and European norms for this sample (t=0.710, p>0.480). However, there was an evident tendency for the Argentinean straylight values to be higher than the European norms, mainly among the young subjects (between 18 and 30 yrs), and to approach the norms when subjects are older (equations fit to the data:

$\log(s)=\log(7*(1+(\text{age}/65)^4))$  - European norms;

$\log(s)=\log(8.54*(1+(\text{age}/63.41)^4))$  - Argentinean data).

**Conclusions:** Consistent with European norms, light-scattering increases with age

in the Argentinean sample. This increase is thought to be due, in large part, to age-related changes in lens structure and density. Although the differences between the populations are not significant, the tendency for Argentinean data (mainly young subjects) to have higher straylight values than European values is in the opposite direction from that expected from a dark-eyed population, since darker eyes means less straylight. This suggests the hypothesis that environmental light differences, maybe latitude-dependent (San Miguel de Tucumán, ARG, latitude 26.81°S, European latitudes between 40°N to 55°N) differences could be associated with differences in straylight values among young subjects, and a biological factor could rule straylight among older subjects, getting them close to the norms.

**Commercial Relationships:** Emilia Longhi, None; Luis Issolio, None; Elisa Colombo, None; Dora Fix Ventura, None; Marcelo Fernandes da Costa, None  
**Support:** FAPESP 08/58731-2, FAPESP 02/12733-8, CNPq, CAPES, IBN-Net; DFV and MFC are CNPq Research Fellows.

**Program Number:** 1884 **Poster Board Number:** D842

**Presentation Time:** 1:45 PM - 3:30 PM

**Flicker Sensitivity and Straylight Measurement**

Thomas J. Van Den Berg, Joris E. Coppens, Bastiaan Kruijt, Luuk Franssen. Ophthalmic Research, Netherlands Inst for Neurosciences, Royal Acad., Amsterdam, The Netherlands.

**Purpose:** Design and population testing of a flicker sensitivity assessment technique corresponding to the compensation comparison design for straylight measurement. Intended use of this flicker sensitivity test is twofold: for checking subjects' capability to perform the straylight test and as a test for retinal integrity for other purposes.

**Methods:** The compensation comparison design for straylight assessment (ARVO2005 #4315) was adapted to include the possibility of flicker sensitivity assessment. The test was implemented in the C-Quant straylight meter from Oculus, using home made software (Matlab). Visual field lay-out was identical, as well as the subject's 2AFC task. A comparable reliability criterion (ESD) was used. The peripheral annulus was silent, as well as one of the two half fields in the center. The other half field flickered at 8 Hz, with modulation depth according to an adaptive staircase procedure "stochastic approximation" (Treutwein VR1995). Both half fields and the surrounding field had (mean) luminance of 25 cd/msq. Population test was performed in science fair settings on 300 subjects. Moreover in the laboratory 20 ophthalmologically well controlled subjects were included. The laboratory group was also used to check whether optical defects, mimicked with trial lenses and scatter filters, had an effect on the flicker test outcome. In this group and 84 science fair subjects repeated measures were performed.

**Results:** Based on the statistics of repeated measures differences in relation to the ESD values, the number of presentations was set at 35, and ESD<0.1 as reliability criterion. Repeated measures standard deviation was 0.08 log units. Overall population modulation threshold variation was -2.04±0.20 log units (0.91% modulation depth), including a small dependence on age (range 6-80 years). Test outcome did not change upon a ten-fold (optical) deterioration in visual acuity and a 5-fold deterioration in straylight.

**Conclusions:** The flicker sensitivity test has adequate precision to check a subject's capability to perform straylight assessment with the compensation comparison method, corresponding about -1.0 log units (10% modulation depth) flicker threshold to be sufficient. Usage of the ESD reliability criterion secures repeated measures standard deviation to be around 0.08 log units in an unexperienced population under sub-optimal (science fair) conditions. This suggests the method to have good sensitivity for detection of retinal sensitivity loss.

**Commercial Relationships:** Thomas J. Van Den Berg, Oculus (P); Joris E. Coppens, None; Bastiaan Kruijt, None; Luuk Franssen, None  
**Support:** None

**Program Number:** 1885 **Poster Board Number:** D843

**Presentation Time:** 1:45 PM - 3:30 PM

**Vision Loss in Healthy Aging: Isolating the Contributions of Eye Optics, and Central Retinal Structure and Function**

David P. Bissig, Robin Roberts, Bruce A. Berkowitz. Anatomy and Cell Biology, Wayne State Univ School of Med, Detroit, MI.

**Purpose:** To use a novel combination of objective, non-invasive metrics to identify the contributions of eye optics and central retinal structure and function to age-related declines in visual acuity and contrast sensitivity.

**Methods:** Young (2 mo.) and mid-aged (6.5 mo.) Long-Evans rats were studied with optokinetic tracking to evaluate visual performance and manganese-enhanced MRI (MEMRI, 44 mg MnCl<sub>2</sub>·4H<sub>2</sub>O / kg body weight, ip) to non-invasively measure eye and central retinal structure and retinal physiology (i.e., regulation of ions like calcium). One eye of each animal was patched to evaluate ion regulation of light- and dark-adapted retina of each rat. Depth of field and refractive state (i.e., optics) were estimated using MEMRI measures of eye morphology (lens thickness, radii of curvature, chamber depths, etc.) and Hughes' schematic eye for the rat (Vision Research 19, 1979). After scanning, a subset of the mid-aged rats were retained for several months, when vision testing was repeated.

**Results:** Relative to young rats, mid-aged rats have significantly lower visual acuity and contrast sensitivity (P < 0.05). Central intraretinal Mn<sup>2+</sup> uptake was significantly higher in the mid-aged rats, and was correlated with worse acuity (P <

0.05). Optics also differed significantly between groups, and were correlated with acuity ( $P < 0.05$ ). Sequential regression analyses revealed that, after accounting for animal age, significant ( $P < 0.05$ ) relationships remained between visual acuity and both optics and Mn2+ uptake data. After 6.5 mo., contrast sensitivity, but not acuity, continued to decline ( $P < 0.05$ ). Animals with higher retinal Mn2+ uptake showed greater declines in contrast sensitivity ( $P < 0.05$ ).

**Conclusions:** These data raise the possibility that, in addition to the expected role of optics, changes in central intraretinal ion regulation also participate in declines in visual function. These data extend previous literature that links neuronal calcium regulation to age-related functional declines in other CNS structures.

**Commercial Relationships:** David P. Bissig, None; Robin Roberts, None; Bruce A. Berkowitz, None  
**Support:** NIH Grant F30AG034752

**Program Number:** 1886 **Poster Board Number:** D844

**Presentation Time:** 1:45 PM - 3:30 PM

#### **An Investigation of the Age-Related Changes in Four Visual Functions**

James R. Drower, Nikita-Rae C. Piercey, Kayla M. Dempsey, Avery E. Earle. Psychology, Memorial University of Newfoundland, St. John's, NL, Canada.

**Purpose:** An investigation of the visual changes that occur with age can reveal much about the underlying mechanisms of vision. Rates of decline of different visual functions can be compared to infer whether they are mediated by the same or different underlying optical/neural mechanisms. Furthermore, rates of decline can be compared to changes known to occur within the senescent visual system to elucidate the role of visual system components. In the present study, we investigate the changes that occur with age in four visual functions.

**Methods:** Participants consisted of a sample of young adults (20 to 40y; N=21, age=22.6±4.6y), and a sample of middle-aged and senior adults (50+y; N=16; age=62.3±7.6y). All participants had normal healthy vision and were tested while wearing best correction. Participants were tested using a Computer-Based Instrument (CBI) designed by our laboratory. The CBI, which consists of a laptop computer connected to a calibrated, high-resolution monitor, contains tests of resolution acuity, contrast sensitivity (CS), and vernier acuity that follow nearly identical testing procedures. In addition, all participants completed the ETDRS optotype acuity test. The scores of the two age groups were compared and correlational analyses were conducted to determine whether the visual functions correlated with age.

**Results:** The age groups did not differ on vernier acuity or optotype acuity (both  $p > 0.05$ ). Compared to the 50+ group, the young adults had superior resolution acuity (-0.06 v. -0.23 logMAR, respectively,  $p = 0.001$ ). Although, the groups did not differ on CS at low to mid spatial frequencies (1.5, 3, and 6 cpd, all  $p > 0.05$ ), the young adults had higher CS at high spatial frequencies (12 and 18 cpd) compared to the 50+ group (both  $p < 0.05$ ). Furthermore, of all visual functions, only grating acuity and CS at 3, 12, and 18 cpd were correlated with age (all  $p < 0.05$ ).

**Conclusions:** The results suggest that different visual functions undergo different patterns of age-related changes. Resolution acuity declines with age, whereas vernier acuity and optotype acuity remain relatively stable. CS declines with age, but only at high spatial frequencies. Thus, vernier acuity and optotype acuity appear to be limited by different mechanisms than grating acuity and CS at high spatial frequencies.

**Commercial Relationships:** James R. Drower, None; Nikita-Rae C. Piercey, None; Kayla M. Dempsey, None; Avery E. Earle, None  
**Support:** Industrial Research and Innovation Fund

**Program Number:** 1887 **Poster Board Number:** D845

**Presentation Time:** 1:45 PM - 3:30 PM

#### **Relative Speed Discrimination: Effects of Age and Retinal Disease**

Monique J. Leys, James V. Odom. Ophthalmology, WVU Eye Institute, Morgantown, WV.

**Purpose:** To determine the effects of age and retinal pathology on thresholds for speed discrimination in three groups of subjects, young normals, older normals, and patients with central visual field loss due to age-related macular degeneration (AMD).

**Methods:** Five groups of observers made speed discrimination judgments. The groups were younger normals aged 21-50 years, older normals aged  $\geq 60$  years and low vision patients with AMD aged  $\geq 60$  years, low vision patients with diabetic retinopathy aged  $> 60$  and AMD patients treated with anti-VEGF who maintained good binocular visual acuity aged  $> 60$  years. Observers were seated 50 cm from a display that subtended 44.6 arc deg in the horizontal dimension. Pressing a mouse began a trial. During the 833 ms trial, a pattern of 100 white dots on a black background appeared. The observer saw four regions on the screen. Alternating regions of the screen moved in opposite directions, 25 dots in each region, at random locations and moved either left to right or right to left. Dots had a lifetime of 467 ms or were replaced as they moved off of the screen. The observers' task was to determine which of the two directions of motion had faster moving dots.

**Results:** Younger normals ( $p < 0.01$ ) discriminated speed differences better than all of the other groups. None of the other groups differed in their ability to discriminate speed ( $p > 0.10$ ). Age as a variable had a higher correlation with relative speed discrimination than either binocular visual acuity or contrast sensitivity ( $r = 0.5036$ ,  $r = 0.3045$ ,  $r = -0.358$ , respectively). Age was the only

variable which significantly predicted speed discrimination in a multiple regression analysis ( $p < 0.05$ ).

**Conclusions:** The results are consistent with data indicating an age-related decline in motion perception. Given that relative speed discrimination is correlated with mobility performance, the data are also consistent with age-related changes in mobility.

**Commercial Relationships:** Monique J. Leys, None; James V. Odom, None  
**Support:** NIH Grant EY 14841; Research to Prevent Blindness

**Program Number:** 1888 **Poster Board Number:** D846

**Presentation Time:** 1:45 PM - 3:30 PM

#### **Laser Glare and Laser Eye Protection Effects on Pilots During Takeoffs and Landings**

Leon N. McLin, Jr.<sup>1</sup>, Semih S. Kumru<sup>1</sup>, Thomas K. Kuyk<sup>2</sup>, William R. Ercoline<sup>3</sup>, Andrew Y. Cheng<sup>4</sup>, <sup>1</sup>711HPW/RHDO, Air Force Research Laboratory, Brooks City-Base, TX; <sup>2</sup>TASC, Inc., Brooks City-Base, TX; <sup>3</sup>Wyle, Brooks City-Base, TX; <sup>4</sup>711HPW/RHDO, Federal Aviation Administration, Airport and Aircraft Safety Group, TX.

**Purpose:** Illumination of civilian aircrew with visible lasers is an increasing problem. According to the FAA, from January to Nov 2010, there have been 2,555 reports of these types of incidents, usually at night. Even low power lasers can produce intense glare that can create a flight hazard by disrupting crew performance. One way to protect aircrew from glare is to wear laser eye protection (LEP). However, the selective light filtering by LEP can alter the color and visibility of objects in and out of the cockpit, such as displays and runway lighting. We evaluated the effects of different LEP that blocked green laser light for visual compatibility with flight operations and for their impact on flight performance during laser illumination.

**Methods:** Nine pilots performed takeoff and landing maneuvers under night conditions in a flight simulator with and without green (532 nm) laser glare (6 and 60  $\mu\text{W}/\text{cm}^2$ ) and with and without LEP. Three of the LEP were in spectacle format and one was in a moveable shield located between the pilot and windshield. Subjective questionnaires were used to assess the effects of LEP.

**Results:** Subjects noted significant changes in color appearance of cockpit stimuli, in particular color shifts for white, but overall reported only mild levels of difficulty ( $< 2$  out of 10) with their instrument displays. One LEP was rated worse on 14 of 15 items ( $p < .001$ ). Laser glare had significant adverse effects on flight performance and vision that increased as irradiance increased. With 60  $\mu\text{W}/\text{cm}^2$  glare, difficulty ratings for seeing the runway during takeoff and landing increased from near zero to 7.3 and 5.9 out of 10. With LEP, glare was reduced, as were difficulty ratings. This amount varied among LEP, but the best filter difficulty ratings declined to between 1 and 2. In the no laser condition difficulty seeing varied with LEP and ranged between 1 and 3.

**Conclusions:** Low levels of laser glare have an adverse effect on pilot performance during critical phases of flight. Wearing LEP significantly reduces these effects. LEP are available that effectively mitigate glare without significant compromise of vision when glare is not present.

**Commercial Relationships:** Leon N. McLin, Jr., None; Semih S. Kumru, None; Thomas K. Kuyk, None; William R. Ercoline, None; Andrew Y. Cheng, None  
**Support:** None

**Program Number:** 1889 **Poster Board Number:** D847

**Presentation Time:** 1:45 PM - 3:30 PM

#### **The Role of Lighting and Contrast in Low Vision**

William H. Seiple<sup>1</sup>, Edward Pei<sup>1</sup>, Vernon Odom<sup>2</sup>, Bruce Rosenthal<sup>1</sup>. <sup>1</sup>Research, Lighthouse International, New York, NY; <sup>2</sup>Ophthalmology, West Virginia University, Morgantown, WV.

**Purpose:** Lighting and contrast have long been the interventions of choice for patients with low vision. Is common wisdom that increasing the lighting level increases contrast and improves reading performance? We questioned this wisdom based upon known physical properties and psychophysical contrast and luminance gain mechanisms.

**Methods:** We measured reading speeds for printed sentences (one sentence per page) under four levels of attenuation, ranging from 0 log units to 1.8 log units. For each light level, five sentences were read at a given font size (ranging in size from an equivalent of 20/20 to an equivalent of 20/160). We also measured reading speeds to sentences of varying contrast levels from 3.4% to 94% under the four luminance conditions. Two font sizes were used in the contrast experiments (equivalent to 20/40 and 20/100).

**Results:** Five normally sighted subjects and five patients with low vision due to macular disease were tested. Reading speeds from the five sentences at each condition were averaged and plotted as a function of size or contrast. Reading speed as a function of size was best fit by a saturating function. Reading speed increased with increasing size, but reading speed saturated near a size of 20/40 for the normally sighted subjects. Although reading speeds decreased as a function of luminance level for the smallest text size (20/20), the point of saturation did not change with luminance. That is, reading speed for text sizes at and larger than 20/40 did not increase with increasing luminance. Reading speed as a function of contrast also had saturating function. Similar to the acuity data, luminance only had

an influence on reading speed only at the lower contrast levels. At contrasts above 20%, luminance had no influence on reading speed for either font size. Patients showed similar saturating function, with the horizontal position of their data shift corresponding to their acuity and/or contrast threshold elevation.

**Conclusions:** Increases in reading speed with increasing luminance were only observed for text near a subject's acuity level. For text of  $\geq 0.6$  dB above a subject's acuity threshold, increasing light level did not change reading speed. Therefore, magnification aids would be predicted to have a greater influence on reading speed than lighting alone. For contrast, increasing luminance does not change the physical contrast of the text. However, we found no deficits in performance at supra-threshold contrast levels over the range of luminances used in our study.

**Commercial Relationships:** William H. Seiple, None; Edward Pei, None; Vernon Odom, None; Bruce Rosenthal, None  
**Support:** VA Rehabilitation Research & Development

**Program Number:** 1890 **Poster Board Number:** D848

**Presentation Time:** 1:45 PM - 3:30 PM

**Mild Cognitive Impairment And Visual Impairment: Is There A Link?**

Sara Dubuc<sup>1</sup>, Walter Wittich<sup>2</sup>, Julius E. Gomolin<sup>3</sup>, Oscar Kasner<sup>3</sup>, Olga Overbury<sup>1</sup>.

<sup>1</sup>School of Optometry, University of Montreal, Montreal, QC, Canada; <sup>2</sup>Agent de Planification de Recherche, MAB-Mackay Rehabilitation Centre, Montreal, QC, Canada; <sup>3</sup>Ophthalmology-Jewish Gen Hosp, McGill University, Montreal, QC, Canada.

**Purpose:** Recent studies have suggested an association between a number of ocular diseases and pathological Cognitive Impairment (CI). Two ocular pathologies which become more common in older people, Age-related Macular Degeneration (AMD) and Glaucoma, have recently been proposed to be neurodegenerative in nature and, therefore, potentially indicative of Central Nervous System (CNS) dysfunction. CI is a potential complication of the neurodegeneration of the CNS when it is affected by a disease such as Alzheimer's. The brief cognitive assessment used most often for both screening purposes to assess level of cognitive functioning with elderly individuals is the well known Mini Mental Status Exam (MMSE). Recently, however, the MoCA (Montreal Cognitive Assessment) has been developed as an alternative to the MMSE. Although highly correlated with the MMSE, the MoCA may be a more sensitive tool for detecting Mild Cognitive Impairment (MCI), which may precede AD. In the present study, the MMSE and the MoCA were compared among individuals with dry AMD, glaucoma, no visual pathology and mild CI.

**Methods:** The number of participants in each group and their respective mean ETDRS acuities OU were: 28 with AMD (20/27), 25 with glaucoma (20/36) 16 visually healthy people (20/23) and 15 with MCI (20/25). Participants ranged in age between 47 and 89, with a mean of 72 years. The MMSE and the MoCA were administered in random order to all participants.

**Results:** A one-way ANOVA revealed a significant difference among groups on the MoCA,  $F(3,80) = 3.33, p = .03$  and on the MMSE,  $F(3,76) = 4.2, p = .01$ . However, post hoc analyses demonstrated that the difference on the MMSE was only between the visually-healthy and the MCI group, whereas differences on the MoCA were found between the normal group and each of the MCI, glaucoma and AMD groups.

**Conclusions:** Given the results of the ANOVA and post-hoc analysis, the MoCA (but not the MMSE) may be detecting the presence of subtle cognitive changes in a population with early progressive retinal disease. Along with other recent studies also indicating that there may be a link between cognitive impairment and certain visual disorders, this adds to the evidence that neurodegenerative visual diseases of the eye may be linked to CI. Additionally, tests such as the MoCA, which identify CI in the earliest stages, might be the best type of screening tools to use for early detection.

**Commercial Relationships:** Sara Dubuc, None; Walter Wittich, None; Julius E. Gomolin, None; Oscar Kasner, None; Olga Overbury, None  
**Support:** None

**Program Number:** 1891 **Poster Board Number:** D849

**Presentation Time:** 1:45 PM - 3:30 PM

**Visual Test For Quantifying Discrimination Capacity In Ocular Pathologies**

Jose J. Castro, Jose R. Jimenez, Carolina Ortiz, Aixa Alarcon, Rosario G. Anera. Optics, University of Granada, Granada, Spain.

**Purpose:** To check a new visual test, designed as a software, for quantifying discrimination capacity under low-illumination conditions in patients with some ocular pathologies and to study the existence of a correlation between optical quality, as an objective measurement, and the discrimination capacity as visual function to evaluate visual performance.

**Methods:** We checked the test with two groups of observers: patients affected with keratitis and patients with age-related macular degeneration (ARMD). The test consists of the discrimination of luminous peripheral stimuli around a central high-luminance one over a dark background. The task of the subject is to press a button each time a peripheral stimulus is perceived. When the test is finished, the software gives a parameter, called visual-disturbance index, which quantifies the visual disturbances perceived by the observer. The disturbance index takes values of between 0 and 1, in such a way that the greater the index, the lower the

discrimination capacity. We also took data from a visual-quality device based on the double-pass technique. We used the Strehl ratio, a parameter commonly used for estimating overall optical quality, which ranges from 0 to 1. A lower value of this parameter indicates that there is a greater contribution of the aberrations and ocular scattering and therefore poorer optical quality.

**Results:** We found a significant descending correlation for the disturbance index as a function of the Strehl ratio in ARMD ( $r = 0.85, p < 0.05$ ) and keratitis eyes ( $r = 0.81, p < 0.05$ ). In both types of pathological eyes, the lower the Strehl ratio was, the higher the disturbance index was and, therefore, the lower the discrimination capacity was for peripheral stimuli, indicating a higher influence of different visual disturbances perceived by the observer due to the ocular pathology.

**Conclusions:** The visual test developed is a simple test available to any examiner to quantify visual disturbances under low illumination conditions by means of calculating the disturbance index in patients where visual performance is deteriorated. This test is more accurate than some questionnaires used to evaluate, qualitatively, visual disturbances. The effectiveness of the new visual test is reaffirmed by a significant descending correlation between the retinal-image quality and the visual disturbances perceived by the subject.

**Commercial Relationships:** Jose J. Castro, None; Jose R. Jimenez, None; Carolina Ortiz, None; Aixa Alarcon, None; Rosario G. Anera, None  
**Support:** Ministerio de Educación y Ciencia (Spain) grant FIS2009-07482 and Junta de Andalucía (Spain) grant P06-FQM-01359.

**Program Number:** 1892 **Poster Board Number:** D850

**Presentation Time:** 1:45 PM - 3:30 PM

**Assessment of Vision in Severely Visually Impaired Populations**

Ian L. Bailey<sup>1</sup>, Marlina A. Chu<sup>1</sup>, A. Jonathan Jackson<sup>2</sup>, Hasan Minto<sup>3</sup>, Robert B. Greer<sup>1</sup>. <sup>1</sup>School of Optometry, University of California, Berkeley, Berkeley, CA; <sup>2</sup>Department of Ophthalmology and Optometry, Royal Victoria Hospital, Belfast, United Kingdom; <sup>3</sup>Sight Savers International, Islamabad, Pakistan.

**Purpose:** New tests of Visual Acuity (VA) and Contrast Sensitivity (CS) have been designed to provide a simple and efficient means for testing vision in severe visual impairment. To evaluate the efficacy of these tests, we measured VA and CS in 54 subjects with a wide diversity of ocular disorders and visual capacities. Subjects with severe visual impairments were recruited from the California School for the Blind, the Orientation Center for the Blind and the San Francisco Lighthouse.

**Methods:** VA was measured with the Berkeley Rudimentary Vision Test (BRVT) which uses three 25cm-square hinged card-pairs; one presents four Single Tumbling E's (STE's) at 1m, or 25 cm; another has 4 gratings shown at 25 cm; and the third has basic vision tests of White Field Projection (WFP) and Black White Discrimination (BWD). CS was measured with the Berkeley Discs CS test which has 3 double-sided cards used to measure contrast thresholds for the detection of 5 cm discs, with 14 contrast steps to 1.95 log units. The MARS optotype CS test was used for comparison.

**Results:** Binocular VA was assessed in 54 subjects. For 24, Letter Chart VA (LCVA) could be measured (9 at 4 m and 15 at 1 m); for 18, STE VA measurement was required (16 tested at 1m to 20/2000, and 2 tested at 25cm to 20/8000). Two required Grating Acuity measurement (at 25 cm to 20/16000). Eleven did not have measurable VA. (5 had WFP, 1 had BWD and 4 had Light Perception (LP)) We project that, by usual clinical procedures, 20 subjects would have been categorized simply as Count Fingers (CF), and 10 as Hand Motion (HM). The BRVT system uses 13 incremental steps over the same range. BRVT test time averaged about 2 minutes. On 40 subjects, CS could be measured with both the Berkeley Discs and the MARS test. When CS was poor, higher CS scores were obtained with the Berkeley Discs, presumably because of the larger target size and simpler task. Testing was quicker with the MARS test (55 cf 71 sec)

**Conclusions:** The BRVT is shown to provide a simple and efficient means of measuring visual resolution beyond the 20/630 limit of Letter Chart VA. The BRVT uses relatively fine increments for STE VA (from 20/500 to 20/8000), and Grating VA (to 20/16,000.) Categorization using CF or HM is grossly insufficient for assessment of vision in persons with severe visual impairment. For measuring CS in persons with severe vision loss, the large area targets and simpler task of the Berkeley Discs test make it more appropriate than optotype tests.

**Commercial Relationships:** Ian L. Bailey, Copyrights for vision tests. Likely to be commercialized (P); Marlina A. Chu, None; A. Jonathan Jackson, None; Hasan Minto, None; Robert B. Greer, None  
**Support:** Supported by the Bernard A. Newcombe Foundation.

**Program Number:** 1893 **Poster Board Number:** D851

**Presentation Time:** 1:45 PM - 3:30 PM

**Understanding and Reporting Visual Acuity Measurements in Publications of Clinical Research in Retina**

Mariana S. Lopes<sup>1</sup>, Shiri Zayit-Soudry<sup>2</sup>, Ala Moshiri<sup>2</sup>, Susan B. Bressler<sup>2</sup>, Neil M. Bressler<sup>2</sup>. <sup>1</sup>Universidade Nove de Julho, Sao Paulo, Brazil; <sup>2</sup>Retina Division, Johns Hopkins University School of Medicine and Hospital, Baltimore, MD.

**Purpose:** To investigate methods used to report visual acuity in published retina literature, and evaluate understanding of those methods.

**Methods:** All retina papers published in 2008 among four leading clinical journals were reviewed. The full text of each paper was examined by at least two authors, and each method of visual acuity reporting used was recorded. Five residents, four

ophthalmologists in retina training, and five retina faculty were surveyed to evaluate their ability to interpret various visual acuity methods.

**Results:** Among 356 retina papers, 206 reported visual acuity, including 175 (85%) of the 206 which reported Snellen acuities. Other methods included a letter score based on the log of the minimal angle of resolution (logMAR) in 106 papers (51.5%), a letter score derived from the number of letters read on an Early Treatment Diabetic Retinopathy Study (ETDRS) chart in 67 papers (32.5%), decimal notation in 13 papers (6.3%), and fractions other than Snellen equivalent in 1 paper (0.5%). Among the 140 papers using notations other than Snellen, 31 (22.1%) did not provide a Snellen equivalent. The majority of physicians surveyed, regardless of level of training, were unable to translate an ETDRS letter score or logMAR value to an approximate Snellen equivalent correctly.

**Conclusions:** Many publications in major ophthalmic journals do not provide Snellen equivalent of letter scores derived from an ETDRS chart or logMAR values. Journals should consider requiring Snellen equivalents until data show a greater understanding or facility with letter scores or logMAR values.

**Commercial Relationships:** Mariana S. Lopes, None; Shiri Zayit-Soudry, None; Ala Moshiri, None; Susan B. Bressler, None; Neil M. Bressler, None  
**Support:** None

**Program Number:** 1894 **Poster Board Number:** D852

**Presentation Time:** 1:45 PM - 3:30 PM

**Measurement Of Visual Acuity - Landolt Rings Versus Numbers Or Symbols**  
*Klaus Rohrschneider, Axel R. Spittler.* Department of Ophthalmology, University of Heidelberg, Heidelberg, Germany.

**Purpose:** Estimation of visual acuity (VA) in clinical practice mostly is performed with numbers or letters, while in children often simple symbols like Lea-Symbols are used. Even for clinical studies and for exact measurement of follow-up the ETDRS charts use numbers. Besides this testing with Landolt rings offers better comparable results without influence of different recognition of shape. However, it remains unclear whether there are differences between measuring with Landolt rings or other optotypes.

**Methods:** Visual acuity of 2366 eyes of 1395 patients of the Low Vision Department aged 5 to 98 years with all kinds of ophthalmologic diseases was measured in identical manner with Landolt rings and numbers. In addition subgroups were measured using Lea-test. VA was calculated in logMAR and compared for age groups and different ranges of VA.

**Results:** Median VA was  $0.7 \pm 0.52$  logMAR (0.2) and  $0.6 \pm 0.5$  logMAR (0.32) for Landolt rings and numbers, respectively. Correlation between both optotypes was 0.967 for all eyes (0.951 for right or left eyes). Mean Landolt ring VA was one line below number acuity (0.1 logMAR), while especially in eyes with low VA there were more cases with better VA for Landolt ring symbols. The differences between both optotypes were not correlated with visual acuity scores, which ranged from -0.08 logMAR (1.25) to 2.6 (0.1/40), although VA decreased significantly with age ( $p < 0.01$ ).

**Conclusions:** While measurement with numbers especially using the ETDRS charts are the gold standard for scientific assessment of visual acuity, only the use of Landolt rings offers absolute equivalence of different optotypes. The use of Landolt rings is therefore commanded for legal reasons in Europe. For practical reasons numbers or letters are usually used as optotypes. Our results confirm that visual acuity measured with Landolt rings is about 1 line worse as compared to numbers which has to be taken into account when comparing different examinations. However it is not possible to exactly recalculate measurements with different optotypes especially in a Low Vision population.

**Commercial Relationships:** K. Rohrschneider: None. A.R. Spittler: None.  
**Support:** None

**Program Number:** 1895 **Poster Board Number:** D853

**Presentation Time:** 1:45 PM - 3:30 PM

**Test-retest Repeatability For Contrast Sensitivity In Children and Young Adults**

*Susan Kelly, Yi Pang, Chandra Engs, Lauren Foley, Nellie Salami, Audra Sexton.* Illinois College of Optometry, Chicago, IL.

**Purpose:** Contrast sensitivity (CS) testing has become an important tool used to assess patient vision. Currently two letter CS tests, the Pelli-Robson and the Mars chart are often used to assess CS. Both these charts measure patient sensitivity to peak spatial frequencies. These tests are not only quickly administered but have validity and good test-retest repeatability. There are chart-based CS tests that measure sensitivity to contrast across the full range of spatial frequencies that are also rapid but their accuracy and reliability have been less well examined. The present study measured the test-retest repeatability for the Vector Vision CSV-1000E system in visually normal children and young adults.

**Methods:** Twenty-one visually normal adults (mean age=27.96 yrs, range = 22-38) and 16 children (mean age= 7.7 yrs, range =5-12) were tested on the the Vector Vision 1000E chart on two separate visits (average inter-visit duration = 15 wks for adults and 2 wks for children). All subjects were free of ocular pathology, had best-corrected visual acuity of 20/20 or better and wore their habitual correction if needed. The testing procedure followed that recommended by the manufacturer. The chart self-calibrates to a mean luminance of 85 cd/m<sup>2</sup> and testing was conducted at 8 feet.

**Results:** Data were converted to log CS scores for all data analysis. Test-retest repeatability was determined with a Bland-Altman analysis. Both the 95% limits of agreement (and their 95% confidence intervals) and the correlation of repeatability (COR) were calculated. The average test-retest difference was -0.07 log CS for adults and -0.014 for children. The negative values indicate performance improved on the second administration of the test. The 95% limits of agreement (LoA) ranged from  $\pm 0.425$  to  $\pm 0.757$  for adults and  $\pm 0.482$  to  $\pm 0.91$  for children.

**Conclusions:** Both children and adults completed the test in under 3 minutes.

Although the average test-retest difference in logCS between visits is small, it is 3 times that which has been reported for the Pelli-Robson or the Mars chart in adults. The LoA reported for the Pelli-Robson test in visual normals and clinical populations ranges from  $\pm 0.14$  to  $\pm 0.2$ . This is in contrast with the LoA measured in the present study which are 2 to 4 times greater. These values are also larger than those reported for a healthy, older population using the Vector Vision test (Pomerance and Evans, '94). It is possible that test-retest variability varies with the subject's understanding of the instructions; variability in CS estimates will occur if they guess the location of the pattern after they no longer see it.

**Commercial Relationships:** Susan Kelly, M&S Technologies, Inc. (C); Yi Pang, M&S Technologies Inc. (C); Chandra Engs, None; Lauren Foley, None; Nellie Salami, None; Audra Sexton, None  
**Support:** Illinois College of Optometry Research Resource Committee

**Program Number:** 1896 **Poster Board Number:** D854

**Presentation Time:** 1:45 PM - 3:30 PM

**On a New Visual Evaluation Method using Psychophysical Tests and the Candela Unit**

*Airton L. Kronbauer<sup>1,2</sup>, Paulo Schor<sup>1</sup>, Wallace Chamon<sup>1</sup>, Luciana d. Matos<sup>1</sup>, Luis A. Carvalho<sup>1</sup>.* <sup>1</sup>Ophthalmology, Federal University of Sao Paulo, Sao Paulo, Brazil; <sup>2</sup>Hospital Banco de Olhos de Porto Alegre, Porto Alegre, Brazil.

**Purpose:** To develop a psychophysical test for easy and accurate visual evaluation using the international system of units (A), and compare the results between standardized objective and subjective methods (B).

**Methods:** (A) Based on concept of minimum visible threshold, a psychophysical test was developed using a calibrated digital device that is based on the principle of photometry with photodiodes. (B<sub>1</sub>) Subjective measurements of visual acuity were taken, in normal individuals, using ETDRS (logMar) standard charts and compared to the proposed logCandela method (n=126 measurements). (B<sub>2</sub>) Objective (total wavefront RMS) and subjective (ETDRS) measurements were taken between patients in pre and postoperative corneal refractive surgery and compared to the logCandela (n=48 measurements).

**Results:** Correlation between ETDRS and logCandela was 84,14%, calculated by exponential correlation of Pearson and t test ( $p < 0.001$ ). The variability of measurements in examined volunteers and examiners was narrower logCandela method than ETDRS. Pearson linear correlation between objective (total wavefront RMS) and subjective measurements (logCandela and ETDRS) was 88% and 96%, respectively. Wavefront maps, PSF plots, total wavefront RMS, ETDRS and logCandela improved after corneal refractive surgery.

**Conclusions:** In normal eyes, there is a positive correlation between the subjective visual acuity tests performed (ETDRS and logCandela) as well as between these tests and objective measurements (total wavefront RMS). This psychophysical test of luminous intensity with logCandela unit may be used in the daily practice for visual evaluation.

**Commercial Relationships:** Airton L. Kronbauer, None; Paulo Schor, None; Wallace Chamon, None; Luciana D. Matos, None; Luis A. Carvalho, None  
**Support:** None

**Program Number:** 1897 **Poster Board Number:** D855

**Presentation Time:** 1:45 PM - 3:30 PM

**ETDRS Visual Acuity Outcomes in Comparison With Two Automatic Systems in Patients With Macular Diseases in a Follow-up Study**

*Ulrike W. Scheschy<sup>1</sup>, Ramzi G. Sayegh<sup>2,4</sup>, Christian Simader<sup>3</sup>, Florian Sulzbacher<sup>4</sup>, Matthias Bolz<sup>2,8</sup>, Katharina Kefer<sup>1</sup>, Stefan Eisenkoelbl<sup>2,8</sup>, Christopher G. Kiss<sup>2,8</sup>, Ursula Schmidt-Erfurth<sup>2,4</sup>.* <sup>1</sup>Augenklinik, AKH Vienna, Vienna, Austria;

<sup>2</sup>Ophthalmology, <sup>3</sup>Dept of Ophthalmology, <sup>4</sup>Department of Ophthalmology, <sup>5</sup>Ophthalmology & Optometry, <sup>6</sup>Medical University of Vienna, Vienna, Austria;

<sup>7</sup>Department of Ophthalmology, University of Vienna, Vienna, Austria;

<sup>8</sup>Ophthalmology, Medical University Vienna, Vienna, Austria.

**Purpose:** Visual acuity testing is the most sensitive functional test method in patients with macular diseases. The purpose of that study was to compare three VA test methods among each other in patients with geographic atrophy (GA), in patients with choroïdral neovascularisation (CNV), with diabetic macular edema (DME) and in an age matched physiological control group.

**Methods:** 75 eyes of 43 patients were examined 3 times with an interval of 3 month using the three VA test-methods in random order and after optimal refraction. Among the 75 eyes, 20 eyes had GA, 20 eyes had CNV, 20 eyes had DME and 15 eyes did not show any retinal pathology. As test instruments the early treatment diabetic retinopathy study (ETDRS) charts, the EVA (electronic visual acuity) computer and the AR were used. EVA is tested using a held hand device and a laptop, which shows one optotype after another in different sizes. Viewing

distance remains according to protocol always 3 meters. VA test results were compared to each other at each visit and for each macular disease separately.

**Results:** In patients with GA no statistically significant changes in BCVA between the three methods could be detected. In patients with CNV and DME significant changes ( $p < 0.05$ ) in BCVA could be detected for ETDRS VA and EVA in comparison to the AR at each visit. Interestingly in the physiological control group highly significant differences between the 3 VA test methods could be recognized.

**Conclusions:** This study showed that patients with severely impaired visual acuity as in GA can be monitored with all three methods, though mean visual acuity in absolute letters was better for ETDRS VA and EVA in comparison to VA in the AR and seems therefore more adequate if the exact visual function is to be found. In eyes with DME and CNV either an ETDRS or EVA VA test seems mandatory for follow up, as they differed significantly with AR VA. Concerning the control group, sensible differences could be detected for VA in the three systems and there seems to be a learning curve in the follow up that seems not to appear in patients with macular diseases.

**Commercial Relationships:** Ulrike W. Scheschy, None; Ramzi G. Sayegh, None; Christian Simader, None; Florian Sulzbacher, None; Matthias Bolz, None; Katharina Kefer, None; Stefan Eisenkoelbl, None; Christopher G. Kiss, None; Ursula Schmidt-Erfurth, None  
**Support:** None

**Program Number:** 1898 **Poster Board Number:** D856

**Presentation Time:** 1:45 PM - 3:30 PM

#### Effects Of Astigmatic Defocus On Visual Acuity, Contrast Sensitivity And Contrast Adaptation

Arne Ohlendorf<sup>1</sup>, Frank Schaeffel<sup>2</sup>. <sup>1</sup>Institut for Ophthalmic Research, University of Tuebingen, Tuebingen, Germany; <sup>2</sup>Section Neurobiology of Eye, Centre for Ophthalmology, Tuebingen, Germany.

**Purpose:** To determine the effects of the axis of imposed astigmatic refractive errors on visual acuity, contrast sensitivity, and contrast adaptation.

**Methods:** Experiment 1: the effects of imposed positive and negative astigmatic defocus on visual acuity was tested in 9 subjects (mean age  $27.2 \pm 1.8$  years) at 3 different visual acuity levels (logMAR 0.0, logMAR 0.2 and logMAR 0.5) using letter charts. Experiment 2: contrast sensitivity was tested when the axes of +1D or +2D astigmatic defocus were varied at three spatial frequencies (1.5, 3 and 6 c/deg) in 10 subjects (mean age:  $28.2 \pm 3.6$  years), using the FrACT. Experiment 3: adaptation to astigmatic defocus was studied in 10 subjects (mean age  $26.7 \pm 2.4$  years) while the axes of astigmatism were varied. Adaptation was induced with a +3D astigmatic lens while the subjects watched a movie for 10 minutes. Visual acuity was measured before and after adaptation with letter charts.

**Results:** Experiment 1: visual acuity was not dependent on the axes of imposed astigmatic defocus (positive and negative defocus, logMAR 0.0, logMAR 0.2 and logMAR 0.5,  $p > 0.05$ , Tukey-Kramer Test). Experiment 2: using the FrACT, contrast sensitivity was not dependent on the axes of imposed astigmatic defocus at any of the tested spatial frequencies (neither for +1D and +2D astigmatic defocus,  $p > 0.05$ , Tukey-Kramer Test). Experiment 3: an increase in visual acuity was observed (logMAR  $0.068 \pm 0.031$ ,  $p < 0.001$ , paired T-Test) after adaptation to astigmatic defocus, when the axis of astigmatism during adaptation and testing were matched. When the axes were different, adaptation did not improve visual acuity (logMAR  $0.04 \pm 0.09$ ,  $p = 0.19$ , paired T-Test).

**Conclusions:** We found no effect of the orientation of the axis of astigmatism on visual acuity and contrast sensitivity, as tested with letter charts and the FrACT. We also found a meridian selective adaptation to astigmatic defocus. It was not necessary to adapt to the same visual test target - a movie worked well.

**Commercial Relationships:** Arne Ohlendorf, None; Frank Schaeffel, None  
**Support:** Supported by the Centre for Integrative Neuroscience (CIN) and the Bernstein Center for Computational Neuroscience (BCCN), Tuebingen.

**Program Number:** 1899 **Poster Board Number:** D857

**Presentation Time:** 1:45 PM - 3:30 PM

#### Improved Refraction of Patients with Central Visual Field Loss by the Use of Low Contrast Optotypes

Jorgen Gustafsson<sup>1</sup>, Robert Rosen<sup>2</sup>, Maria Brodin<sup>2</sup>, Linda Lundstrom<sup>2</sup>, Peter Unsbo<sup>2</sup>. <sup>1</sup>Section of Optometry and Vision Science, Linnaeus University, Kalmar, Sweden; <sup>2</sup>Biomedical & X-Ray Physics, Royal Institute of Technology (KTH), Stockholm, Sweden.

**Purpose:** People with central visual field loss (CFL) utilize their peripheral vision for all tasks. Their refractive error can differ significantly from that of their previous foveal vision, primarily due to oblique astigmatism, when using eccentric viewing in a preferred retinal locus (PRL). Peripheral refraction for CFL patients, if done at all, is normally performed using subjective refraction with high contrast optotypes. In a previous study, we found that the peripheral resolution of normally sighted persons was affected by defocus when using low contrast optotypes, but not high contrast optotypes (Rosén et al. acc. for IOVS sept 2010, doi: 10.1167/iovs.10-5623). This study investigates the potential benefits of using low contrast optotypes for refraction of CFL patients in a clinical setting.

**Methods:** Patients were recruited at a local low vision clinic and refracted by experienced low vision optometrists. The inclusion criteria was CFL in both eyes and a best corrected high contrast visual acuity of logMAR 1.0 or worse. For every

patient, two separate refractions were performed by using high and low contrast optotypes (100% and 25% respectively); high contrast refractive correction (HCR) followed by low contrast refractive correction (LCR). Then both high and low contrast visual acuity (HC-VA and LC-VA) were evaluated with both of the found corrections, i.e. a total of four acuity measurements were performed.

**Results:** The refraction results are summarized in the table for the patients together with the improvements in HC-VA and LC-VA using LCR compared to HCR. Improvement in LC-VA was found for all patients when using LCR, except for one person, who nevertheless had a subjective preference for LCR.

Patient	HCR	LCR	Improvement in HC-VA with LCR	Improvement in LC-VA with LCR
P1	-0.25 / -0.5 x 50	+1.0	No difference	1 line
P2	+4.0 / -1.25 x 70	+5 / -1.25 x 70	No difference	No difference
P3	0	0 / -2.0 x 15	No difference	3 lines
P4	+2.0 / -1.5 x 100	+3.0 / -2.5 x 140	1 line	1 line
P5	+3.5	+4.0 / -1.0 x 140	No difference	2 lines

**Conclusions:** In this first pilot study the results show that subjective refraction using low contrast optotypes can be useful to find a more optimal correction for CFL patients.

**Commercial Relationships:** Jorgen Gustafsson, None; Robert Rosen, None; Maria Brodin, None; Linda Lundstrom, None; Peter Unsbo, None  
**Support:** None

**Program Number:** 1900 **Poster Board Number:** D858

**Presentation Time:** 1:45 PM - 3:30 PM

#### Effects of Optical Defocus on Resolution Acuity in Preferred Retinal Locus

Karthikeyan Baskaran<sup>1</sup>, Peter R. Lewis<sup>1</sup>, Robert Rosen<sup>2</sup>, Peter Unsbo<sup>2</sup>, Jorgen Gustafsson<sup>1</sup>. <sup>1</sup>Section of Optometry and Vision Science, Linnaeus University, Kalmar, Sweden; <sup>2</sup>Biomedical and X-Ray Physics, Royal Institute of Technology, Stockholm, Sweden.

**Purpose:** Resolution acuity in the peripheral visual field is primarily limited by retinal sampling. In healthy eyes, the correction of peripheral refractive errors does not produce significant visual benefits other than improved detection and low contrast acuity. However, studies (Lundstrom L et al, *Optom Vis Sci*, 2007;84:1046-52) have shown that peripheral refractive corrections improve resolution acuity in subjects with central visual field loss (CFL) who have an established preferred retinal locus (PRL). The aim of this study was to evaluate the effect of optical defocus on high contrast resolution acuity in the PRL.

**Methods:** Resolution acuity was evaluated under spherical defocus in the PRL of three low vision subjects (mean age 75 years) with long standing CFL (due to age-related macular degeneration). Off-axis refractive error at the PRL was measured by an open-field COAS-HD VR aberrometer and was corrected accordingly. The PRL for subject 1 was located at 10° in the temporal visual field (left eye), subject 2 at 20° in the nasal visual field (right eye) and subject 3 at 15° in the inferior visual field (left eye). Stimuli consisting of high-contrast Gabor patches with a visible diameter of 3° were presented on a CRT monitor situated 1.0 meter from the subject. Resolution thresholds for static visual acuity (SVA) and dynamic visual acuity (DVA) were obtained using an adaptive Bayesian algorithm. Fixation was aided using illuminated concentric rings covering  $\pm 25^\circ$  in the visual field. Defocus was altered in 1D steps up to  $\pm 4D$ . When measuring DVA, the sine-wave gratings drifted within the Gaussian envelope at an angular velocity of 1°/sec.

**Results:** Resolution thresholds for both SVA and DVA in the PRL varied significantly with the amount of optical defocus. The results show a 2 - 3 line decrease (logMAR) in SVA and DVA with 4 D positive and negative defocus. There was no significant difference between SVA and DVA with increasing defocus. In the absence of defocus, SVA was significantly better than DVA in the PRL.

**Conclusions:** Defocus as low as one dioptre has an impact on both static and dynamic high contrast resolution acuity for CFL subjects using a PRL. The results of this study suggest that, for CFL subjects using a PRL, resolution acuity is not only sampling limited but also influenced by the optics of the eye.

**Commercial Relationships:** Karthikeyan Baskaran, None; Peter R. Lewis, None; Robert Rosen, None; Peter Unsbo, None; Jorgen Gustafsson, None  
**Support:** This study is supported by the Faculty of Natural Sciences and Technology, Linnaeus University, Kalmar, Sweden and the foundation Sparbanksstiftelsen Kronan.

**Program Number:** 1901 **Poster Board Number:** D859

**Presentation Time:** 1:45 PM - 3:30 PM

#### Influence of Contact Lens-Induced Optical Defocus on Peripheral Visual Acuity and Contrast Sensitivity

Percy Lazon De La Jara<sup>1,2</sup>, Fabian Conrad<sup>1</sup>, Padmaja R. Sankaridurg<sup>1,3</sup>, Darrin Falk<sup>1,3</sup>, Arthur Ho<sup>1,2</sup>. <sup>1</sup>Brien Holden Vision Institute, Sydney, Australia; <sup>2</sup>School of Optometry and Vision Science, University of New South Wales, Sydney, Australia; <sup>3</sup>Vision CRC, Sydney, Australia.

**Purpose:** To investigate the influence of defocus induced by soft contact lenses (SCL) on contrast sensitivity (PCS) and visual acuity (PVA) in the peripheral visual field.

**Methods:** Two novel designs of SCL (Lotrafilcon B, CIBA Vision, USA) were tested: a higher (HD) and a lower (LD) design that introduce positive peripheral

powers relative to on-axis power. Myopic participants wore the HD SCL with a relative peripheral power of +7.50D (n=14) and the LD SCL with a relative peripheral power of +4.00D (n=13). All participants wore a commercially-available single vision SCL (Loftrafilcon B, CIBA VISION, USA) as a control. Central and peripheral refraction were measured using a modified Shin-Nippon NVision K5001 autorefractor. PCS and PVA were assessed at the 30° temporal (TF) and nasal (NF) visual field using a computer-based test; sinusoidal gradation annuli of 2 cycles per degree for PCS (tandem pairs); Landolt C for PVA; both stimuli were presented tachistoscopically (200 ms) and a staircase procedure (1-up-3-down) was used to determine threshold. Paired t-tests were used to test for differences between lenses and retinal visual fields.

**Results:** Both novel SCLs showed a significant increase in relative myopic defocus at the NF and TF at 30° field compared to the control ( $p < 0.05$ ). There was nasal-temporal asymmetry, the induced myopic defocus (M) being greater in the NF (LD -2.25±2.00D, HD -3.85±1.23D) than the TF (LD -0.45±1.01D, HD -1.13±1.18D). The nasal retina (TF) has greater PCS irrespective of which lens was worn ( $p < 0.05$ ), however for PVA this effect was not observed with the novel lenses. Compared to the control, the HD design decreased PCS in both peripheral locations ( $p < 0.05$ ) whereas PVA was not affected in NF and the LD design decreased PCS only in the nasal field, PCS in the temporal field and PVA remained unaffected ( $p > 0.05$ ).

**Conclusions:** PCS is sensitive to peripheral defocus induced by SCL. To a lesser extent, PVA in the TF is also influenced by SCL-induced defocus. In agreement with previous findings, the nasal retina has greater PCS than the temporal retina. The refractive status at 30° field influences peripheral visual performance.

**Commercial Relationships:** Percy Lazon De La Jara, Ciba Vision (F); Fabian Conrad, Ciba Vision (F); Padmaja R. Sankaridurg, Ciba Vision (F), US7665842 (P); Darrin Falk, Ciba Vision (F); Arthur Ho, Ciba Vision (F), US70254608 (P), US7665842 (P)

**Support:** Brien Holden Vision Institute, Australian Government CRC Scheme (Vision CRC), Ciba Vision

**Program Number:** 1902 **Poster Board Number:** D860

**Presentation Time:** 1:45 PM - 3:30 PM

**Factors Affecting Visual Acuity for Broadband Optotypes as a Function of Duration**

J Jason McAnany, Kenneth R. Alexander, Mahnaz Shahidi. Ophthalmology and Visual Sciences, University of Illinois at Chicago, Chicago, IL.

**Purpose:** Visual acuity (VA) for broadband letter optotypes is known to improve with increasing exposure duration. The purpose of this study was to determine the effect of duration on three factors that are related to VA: equivalent intrinsic blur, object spatial frequency, and equivalent retinal spatial frequency.

**Methods:** VA of eight visually normal individuals (ages 22 to 59) was measured for a set of tumbling E optotypes presented on a computer display for 59 ms and 590 ms. The Es were either unblurred or blurred through convolution with Gaussian functions of different widths ( $\sigma = 0.2, 0.8$  or  $3.2$  arcmin). Equivalent intrinsic blur ( $\sigma_{im}$ ) was estimated with a standard model:  $MAR = MAR_0 [1 + (\sigma_{stim}/\sigma_{im})^2]^{0.5}$ , where  $\sigma_{stim}$  is the width of the Gaussian convolved with the stimulus, MAR is VA for a given value of  $\sigma_{stim}$ , and  $MAR_0$  is VA for the unblurred stimulus. The object spatial frequencies mediating VA (cycles per letter; cpl) were derived from plots of log MAR vs. log  $\sigma_{stim}$ . Object spatial frequency was converted to equivalent retinal spatial frequency (cycles per degree; cpd) based on target angular subtense.

**Results:** The increase in duration produced a statistically significant improvement in unblurred VA (decrease in log  $MAR_0$ ), as expected ( $p < 0.01$ ). In comparison, the change in duration did not significantly affect equivalent intrinsic blur ( $\sigma_{im}$ ) ( $p = 0.25$ ), as a result of similar temporal integration for the different values of stimulus blur. The increase in duration produced a statistically significant decrease in object spatial frequency (cpl) ( $p < 0.01$ ), but not equivalent retinal spatial frequency (cpd) ( $p = 0.16$ ).

**Conclusions:** The decreases in log  $MAR_0$  and object spatial frequency together with the constant values of equivalent intrinsic blur and equivalent retinal spatial frequency for these two durations do not support scale invariance. Instead, visual acuity is based on different object spatial frequency information at different durations.

**Commercial Relationships:** J Jason McAnany, None; Kenneth R. Alexander, None; Mahnaz Shahidi, None

**Support:** NIH research grants EY019510 (JM), EY008301 (KA), EY014275 (MS); NIH core grant EY001792; Dept of VA (MS); RPB Senior Scientific Investigator Award (MS).

**Program Number:** 1903 **Poster Board Number:** D861

**Presentation Time:** 1:45 PM - 3:30 PM

**Image Enhancement Improves Visual Search Performance For Patients With Impaired Vision**

PremNandhini Satgunam, Gang Luo, Eli Peli. Ophthalmology, Schepens Eye Research Institute, Boston, MA.

**Purpose:** Measure the effect of JPEG image enhancement on reaction time (RT) and error rate (ER) in a visual search task.

**Methods:** Subjects pointed to an object in a natural image that match a given

search object as soon as possible on a touch screen computer monitor. Three categories of natural images: human group photos (Faces), indoor scenes (Indoor) and collections of similar objects (Collection) were collected from the Internet. Images were randomly presented with or without enhancement. The enhancement was realized by boosting a mid-to-high frequency band in the discrete cosine transform (DCT) coefficients of the image luminance component. Five patients (VA: 20/50 to 20/200) participated.

**Results:** Average RT reduced significantly ( $p = 0.03$ , Wilcoxon Signed Rank test) with enhancement for both Faces (from  $12.2s \pm 5$  to  $9s \pm 7$ ) and Collection (from  $6.5s \pm 2$  to  $5.8s \pm 2$ ). However a non-significant ( $p = 0.3$ ) increase in average RT was observed for Indoor images with enhancement (from  $7.1s \pm 6$  to  $8.3s \pm 4$ ). The overall average ER with and without enhancement was 19.6% and 23% respectively. The ER was not significantly different between with and without enhancement for all the three categories ( $p > 0.08$ ).

**Conclusions:** Previous studies (Fullerton et al., JOSA A 2007) have shown that patients with impaired vision prefer MPEG enhanced videos. Our results demonstrated an improvement in search task performance with similar image enhancement. Performance improvement was not seen with Indoor images. It is possible that Face and Collection images have to be performed using bottom-up image information whereas for Indoor images, some level of top-down knowledge can be used to aid the search, which might somewhat mask the enhancement effect.

**Commercial Relationships:** PremNandhini Satgunam, None; Gang Luo, None; Eli Peli, None

**Support:** NIH Grants EY016093, EY595722

**Program Number:** 1904 **Poster Board Number:** D862

**Presentation Time:** 1:45 PM - 3:30 PM

**Evaluation Of Reading Errors Relative To Microperimetry Findings**

Gianfrancesco M. Villani<sup>1,4</sup>, Giovanni Sato<sup>2</sup>, Donald C. Fletcher<sup>3</sup>, Ronald A. Schuchard<sup>4</sup>, Roberta Rizzo<sup>3</sup>, Carlo Camerucci<sup>1</sup>. <sup>1</sup>Ophthalmology, <sup>1</sup>Unione Italiana Ciechi Ipovedenti Verona, Verona, Italy; <sup>2</sup>Centro di Riabilitazione Visiva, Ulss16, Ospedale S. Antonio, Padova, Italy; <sup>3</sup>Ophthalmology, California Pacific Medical Center, San Francisco, CA; <sup>4</sup>VA Palo Alto Rehabilitation R&D Service, Stanford Institute of Neuro-Innovation & Translational Neurosciences, Palo Alto, CA.

**Purpose:** To investigate the relationship between microperimetry findings and reading errors on standardized charts in Italian

**Methods:** Multicentric study. 44 eyes of 40 patients with central scotoma(s) were studied. Clinical diagnoses were: AMD (non neovascular and neovascular), myopic maculopathy, macular edema, macular hole, macular pucker, and central serous retinopathy. All patients referred symptoms of blurred vision and subjectively reduced reading ability. Main outcome measures were BCVA (ETDRS at 2 and 1 m), Contrast Sensitivity (Pelli-Robson), reading performance (Italian MN-Read and SK-Read Charts), and location of central scotoma(s) relative to PRL. Microperimetry was performed by means of either a CenterVue MAIA, a Nidek MP-1, or an OPKO OCT-SLO, depending on the study location. Reading rates and errors were recorded, and the latter classified as right or left as they occurred on the side of a word or within it. Missing words were classified as left or right errors relative to their location within a block. When lateral classification did not appear well-defined, the error was marked as "other"

**Results:** Age median (range) was 75 (38-90), Visual Acuity 20/150 (20/20-20/919), Log Contrast Sensitivity 0.75 (1.35-0). Reading errors median (range) was 2 (0-13) for MN-Read and 10.5 (3-31) for SK-Read, blocks read were 8 (12-1) for MN-Read and 6 (12-1) for SK-Read, and logMAR reading acuity was 0.67 (0.2-1.37) for MN-Read and 0.92 (0.24-1.35) for SK-Read. SK-Read errors (2.5/block) were very significantly more than MN-Read errors (0.8/block). SK-Read showed a trend of errors to the right side of words being related to right sided scotomas and of left sided errors to left sided scotomas, although it did not result statistically significant. Grouping analysis helped differentiate scotoma impact on high and low acuity ranks

**Conclusions:** SK-Read demonstrated much more sensitive to scotoma induced errors than MN-Read. Verbalization of such a high number of errors through the SK-Read allows a deeper insight into PRL function and scotoma interference on reading. The worse acuity score on SK-Read suggests that reading text without contextual clues (e.g. phone books, technical directories) needs stronger effort and possibly higher magnification for low vision patients to read

**Commercial Relationships:** Gianfrancesco M. Villani, None; Giovanni Sato, None; Donald C. Fletcher, None; Ronald A. Schuchard, None; Roberta Rizzo, None; Carlo Camerucci, None

**Support:** None

**Program Number:** 1905 **Poster Board Number:** D863

**Presentation Time:** 1:45 PM - 3:30 PM

**Designing Adaptable Training Procedures To Improve Reading With Central Vision Loss**

Tingting Liu, Gunther Wagoner, Gordon E. Legge. Department of Psychology, University of Minnesota, Minneapolis, MN.

**Purpose:** Macular degeneration often causes severe impairment of reading function due to central vision loss. It has been shown that peripheral reading speed can be improved through perceptual training in people with normal vision. However, applying a similar training protocol to people with low vision faces several

practical issues. Previously, we have described an internet based home training protocol to facilitate subject participation. Here, we report on a pilot project in which we customized the training stimuli to address individual differences in the characteristics of the central scotoma and preferred retinal locus (PRL). Stimuli were chosen with the goal of maximizing the size of the visual span for reading.

**Methods:** Four subjects with juvenile onset forms of macular degeneration participated in home-based training (age from 45 to 57 yrs old, acuity from 0.48 to 1 logMAR). MPI microperimetry was conducted in the lab before and after all other tests. Pre and post tests at the subject's home included flashcard reading speed, Rapid Serial Visual Presentation (RSVP) reading speed and visual span measurements. Training (one hour per day for four days, also at the subject's home) consisted of either repeated RSVP reading, or a word recognition task. The retinal location and orientation (horizontal or vertical) of letter strings were selected to provide a suitable visual span for reading, centered on the subject's PRL, and not obstructed by the scotoma.

**Results:** Two subjects had PRLs on the left side of the scotoma, and were trained with vertical RSVP reading, where letters were rotated clockwise and arranged in the vertical direction. They both showed a gain due to training for vertical RSVP reading (49 word/min and 52 word/min, respectively), with partial transfer to vertical flashcard reading, and also to horizontal RSVP and flashcard reading. One subject had the PRL below the scotoma and was trained with the horizontal word recognition task. He gained 39 word/min for RSVP reading and 18 word/min for flashcard reading. One subject had a central island of vision and a large ring scotoma. He fixated with his residual functioning fovea while RSVP training stimuli were presented in his lower visual field outside the scotoma. He demonstrated a training gain of 106 word/min for eccentric RSVP reading.

**Conclusions:** It may be useful to take into account the variability in the nature of central-field loss and the location of the PRL when designing a perceptual training procedure for enhancing reading performance in macular degeneration.

**Commercial Relationships:** Tingting Liu, None; Gunther Wagoner, None; Gordon E. Legge, None  
**Support:** NIH Grant EY002934

**Program Number:** 1906 **Poster Board Number:** D864

**Presentation Time:** 1:45 PM - 3:30 PM

**Spatial-frequency Requirements For Reading Revisited**

MiYoung Kwon<sup>1,2,4</sup>, Gordon E. Legge<sup>2b</sup>. <sup>1</sup>Department of Psychology, University of Southern California, Los Angeles, CA; <sup>A</sup>Psychology, <sup>B</sup>Department of Psychology, <sup>2</sup>University of Minnesota, Minneapolis, MN.

**Purpose:** Legge et al. (Vision Res., 1985) measured reading speed for text that was low-pass filtered with a range of cutoff spatial frequencies. Above 2 cycles per letter (CPL) reading speed was constant at its maximum level. For cutoff frequencies below 2 CPL, reading speed decreased rapidly. It remains unresolved why the critical cutoff frequency for reading speed is near 2 CPL. Previous research indicates that two important factors limiting reading speed are the spatial resolution of individual letters and the size of the visual span (the number of letters that can be recognized without moving the eyes). In this study, we asked whether the bandwidth requirement for rapid reading can be related to the effects of bandwidth on letter recognition and the size of the visual span.

**Methods:** Visual span profiles were measured by asking participants to recognize letters in trigrams (random strings of three letters) flashed for 150 ms at varying letter positions left and right of the fixation. Over a block of trials, a profile was built up showing letter recognition accuracy versus letter position. The area under this profile was defined to be the size of the visual span. Reading speed was measured with Rapid Serial Visual Presentation (RSVP). The size of the visual span and RSVP reading speed were measured using low-pass filtered letters with various cutoff frequencies (0.8–2.5 CPL). Recognition data for individual low-pass-filtered letters, obtained under similar testing conditions, were available from a previous study.

**Results:** We found that the size of the visual span and RSVP reading speed showed similar dependence on spatial-frequency bandwidth. Both the size of the visual span and reading speed increased with cutoff frequency up to a critical cutoff of 1.4 CPL, which is lower than the previous estimate of 2 CPL. A regression analysis using the size of the visual span as a predictor indicated that 92% of the variability in RSVP reading could be explained by the size of the visual span.

**Conclusions:** These results are consistent with the hypothesis that the visual span plays a limiting role in reading speed. Comparison of these findings with our previous results on single letter recognition suggests that the bandwidth requirements for reading and the size of the visual span are closely linked to the bandwidth requirement for single letter recognition.

**Commercial Relationships:** MiYoung Kwon, None; Gordon E. Legge, None  
**Support:** NIH Grant R01 EY002934

**Program Number:** 1907 **Poster Board Number:** D865

**Presentation Time:** 1:45 PM - 3:30 PM

**Effect of Type-Font on Reading Performance in Age-Related Macular Degeneration**

Linda Lillakas<sup>1</sup>, Luminita Tarita-Nistor<sup>1</sup>, Dianne Lam<sup>2</sup>, Michael H. Brent<sup>1,3</sup>, Martin J. Steinbach<sup>1,3</sup>, Esther G. Gonzalez<sup>1,3</sup>. <sup>1</sup>Vision Science Research Program, Toronto Western Hospital, Toronto, ON, Canada; <sup>2</sup>Psychology, Ryerson University,

Toronto, ON, Canada; <sup>3</sup>Department of Ophthalmology and Vision Sciences, University of Toronto, Toronto, ON, Canada.

**Purpose:** The requirements for reading with peripheral vision are different from those for reading with central vision. The aim of this research was to identify the influence of four common type-fonts on reading performance in people with age-related macular degeneration (AMD).

**Methods:** Twenty-four people with normal vision and 19 patients with AMD participated. Four versions of the MNRead charts were printed using common type-fonts: 1) Times New Roman (proportional spaced, serif), 2) Courier (mono spaced, serif), 3) Arial (proportional spaced, sans serif), and 4) Andale Mono (mono spaced, sans serif). All tests were done binocularly. Reading measures were: reading acuity, critical print size, and maximum reading speed.

**Results:** For people with normal vision, Andale Mono yielded the best reading acuity ( $-0.17 \pm .05$  logMAR), critical print size ( $.05 \pm .11$  logMAR), and maximum reading speed (233.06  $\pm$  41.69 wpm). With this chart, the largest proportion of people (83%) read the full sentence at the smallest print size (20/13). In all measures, people with normal vision had the worst performance with the Times New Roman font. Patients performed best for the majority of measures on the Courier chart: it yielded the best reading acuity ( $.56 \pm .17$  logMAR), critical print size ( $.70 \pm .20$  logMAR), and the second fastest maximum reading speed (104.22  $\pm$  61.43 wpm). Patients read more lines on the Courier chart than on any other charts. Patients read fastest on Andale Mono charts (107.12  $\pm$  56.57 wpm). In all measures, patients with AMD performed the worst with the Arial chart.

**Conclusions:** Reading performance of patients with AMD benefits from mono-spaced and serif type-font.

**Commercial Relationships:** Linda Lillakas, None; Luminita Tarita-Nistor, None; Dianne Lam, None; Michael H. Brent, None; Martin J. Steinbach, None; Esther G. Gonzalez, None

**Support:** The Milton Harris Fund for Adult Macular Degeneration, NSERC Grant A7664, Krembil Family Foundation

**Program Number:** 1908 **Poster Board Number:** D866

**Presentation Time:** 1:45 PM - 3:30 PM

**The Role of Context and Eye Movements in Reading in Elders with "Good" Acuity**

Lori A. Lott<sup>1</sup>, Marilyn E. Schneck<sup>1,2</sup>, Gunilla Haegerstrom-Portnoy<sup>2,1</sup>, Susan Hewlett<sup>1</sup>, John A. Brabyn<sup>1</sup>. <sup>1</sup>Smith-Kettlewell Eye Research Institute, San Francisco, CA; <sup>2</sup>School of Optometry, University of California, Berkeley, Berkeley, CA.

**Purpose:** We have previously presented results on reading performance in elderly observers using tests that differed in the extent to which the reading material contained contextual information and required eye movements. The purpose of the present study is to re-evaluate the relative contributions of these variables in an additional sample of older readers using an important additional test condition. Specifically, we have included a rapid serial visual presentation (RSVP) task requiring no eye movements, which also lacks contextual information (random RSVP).

**Methods:** Subjects were 21 elderly individuals (mean age = 79.1 yrs) with near high contrast acuity better than 20/32 equivalent ( $\leq 0.20$  logMAR) who participated in the fifth phase of the Smith-Kettlewell Institute (SKI) Longitudinal Study. All completed an extensive battery of vision tests and a cognitive screening test (mental alternation test: MAT). Reading rates in correct words per minute (wpm) were measured with three different tests: the Pepper Visual Skills for Reading test, MNRead test, and rapid serial visual presentation (RSVP) tests. The RSVP reading tests consisted of: 1) random words similar to the Pepper test, and 2) sentences similar to the MNRead at the same print size (1M) and 0.1 log unit larger (1.3 M) as the Pepper test. Demographic information, and data on medical and eye health status were also collected. Unlike the Pepper test and the random word RSVP test, the MNRead and sentence RSVP tests provide contextual information and RSVP sentences are presented one word at a time on a monitor, which does not require eye movements.

**Results:** Median reading rates measured by the MNREAD (182.9 wpm) and all three versions of the RSVP tests were significantly faster than those obtained with the Pepper test (90.0 wpm). However, MNRead was not significantly different from the random RSVP (163.9 wpm), nor did the difference between RSVP\_1.0 M (386.5 wpm) and RSVP\_1.3 M (394.7 wpm) size tests attain statistical significance in this sample of elders with good high contrast acuity.

**Conclusions:** In agreement with previous research, adding context and eliminating the need for eye movements both improve reading performance in elderly observers. This study provides further support for the hypothesis that context and eye movements provide approximately equal contributions to reading performance.

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

**Support:** NIH Grant EY09588 (to JAB), NIDRR Grant H133E060001 (to JAB), and SKERI



**Program Number:** 1909 **Poster Board Number:** D867

**Presentation Time:** 1:45 PM - 3:30 PM

**Gaze Behaviour And Mobility Performance Among Older Adults With Age-Related Macular Degeneration**

Alex A. Black, Ashley Burns, Ric Le, Gary Venz, Stephen Witt, Zhichao Wu, Joanne Wood. School of Optometry, Queensland University of Technology, Kelvin Grove, Australia.

**Purpose:** There is limited research linking gaze behaviour and mobility, particularly in high-risk falls populations such as older adults with age-related macular degeneration (AMD). This study examined gaze behaviour and mobility performance among older adults with AMD when walking in unfamiliar, challenging real-world environments, and assessed the effect of the inclusion of a secondary search task on performance.

**Methods:** The gait and eye movement patterns of nine older adults with AMD (mean age 78 ± 6 years) were assessed while navigating an indoor mobility course which was a 20m long, level, well-illuminated corridor, and included 34 floor-based obstacles of varying contrast and size. Participants walked along the course at their natural walking pace, and instructed to avoid contact with obstacles whilst wearing a video-based mobile head-mounted eye-tracker (ASL). An additional run included a secondary search task, which was to locate a specially marked door along the course. The order of the runs was randomised. Outcome measures included mobility performance (walking velocity, stride length and obstacle errors), as well as gaze behaviour measures (fixations per second, fixation duration and time fixated on obstacles).

**Results:** For all runs, a higher rate of obstacle errors was significantly associated with more fixations per second, greater fixation duration and less time spent fixating on obstacles ( $p < 0.001$ ). In addition, participants adopted more cautious gait patterns during the secondary search task, exhibiting a 12% decrease in walking velocity and 8% decrease in stride length ( $p < 0.05$ ). Importantly, obstacle errors did not increase with the inclusion of the search task. Fixation durations also increased by 7% with the inclusion of the search task, along with a reduction in percent of time spent fixating on obstacles (by 9%) ( $p < 0.05$ ).

**Conclusions:** These findings suggest that mobility performance is enhanced when more saccadic and scanning eye movements patterns (fewer fixations per second and shorter fixation durations) are adopted. In addition, the adaptive gait changes in the presence of a secondary search task appear to be an appropriate compensatory strategy to minimize obstacle contact in unfamiliar, challenging real-world environments.

**Commercial Relationships:** Alex A. Black, None; Ashley Burns, None; Ric Le, None; Gary Venz, None; Stephen Witt, None; Zhichao Wu, None; Joanne Wood, None

**Support:** None

**Program Number:** 1910 **Poster Board Number:** D868

**Presentation Time:** 1:45 PM - 3:30 PM

**Recognition of Ramps and Steps by People with Low Vision**

Tiana M. Bochsler, Christopher S. Kallie, Gordon E. Legge, Rachel Gage. Psychology, University of Minnesota, Twin Cities, Minneapolis, MN.

**Purpose:** Visual accessibility is the use of vision to travel efficiently and safely through an environment, to perceive the spatial layout of the environment, and to update one's location in the layout. Legge et al. (J. Vis., 2010) described the effects of lighting, geometry, and surface properties on the recognition of ramps and steps by normally sighted subjects who wore blurring goggles to reduce their acuity. Here we ask whether the results generalize to low vision.

**Methods:** Nine low vision subjects participated aged 33 to 60 with heterogeneous diagnoses, and acuity from 20/220 to 20/960. They viewed a sidewalk interrupted by one of five possible targets: a single step up or down, a ramp up or down, or flat. In a block of trials, subjects reported which of the five targets was shown, and percent correct was computed. Lighting was from overhead fluorescent bulbs or from artificial windows. Viewing distance was 5, 10 or 20ft from the target. Performance was compared with a group of normally sighted subjects who viewed the targets monocularly through goggles with two levels of blur having effective acuities roughly spanning the low-vision range (20/135 to 20/900).

**Results:** A plot of overall percent correct vs. acuity revealed that all low-vision subjects outperformed interpolated levels of the goggle wearers. However, the patterns of performance were similar for the two groups. A step up was more recognizable than a step down for both groups. Both groups performed best at the middle (10ft) distance, and the low vision group performed best with window lighting, an effect found in some conditions with the goggle wearers. The order of target performance from best to worst was the same for the low vision group and the lesser blur goggle wearers: step up, step down, flat, ramp down and ramp up.

**Conclusions:** The overall performance advantage for low-vision subjects over goggle-wearing normals may be due to differences in real-world experience, or possibly to the optical properties of the goggles. Despite this difference, the qualitative effects of distance, lighting and target type were similar for the normal and low-vision groups.

**Commercial Relationships:** Tiana M. Bochsler, None; Christopher S. Kallie, None; Gordon E. Legge, None; Rachel Gage, None

**Support:** NIH grant EY017835

**Program Number:** 1911 **Poster Board Number:** D869

**Presentation Time:** 1:45 PM - 3:30 PM

**Objective Quantification Of Physical Activity And Travel Outside The Home In Age-Related Macular Degeneration**

Emilie S. Chan<sup>1</sup>, Chad Hochberg<sup>1</sup>, Eugenio Maul<sup>1</sup>, Luigi Ferrucci<sup>2</sup>, David S. Friedman<sup>1</sup>, Pradeep Y. Ramulu<sup>1</sup>. <sup>1</sup>Wilmer Eye Institute, The Johns Hopkins Medical Institutions, Baltimore, MD; <sup>2</sup>Clinical Research Branch, National Institute of Aging, Baltimore, MD.

**Purpose:** Decreased visual acuity (VA) is associated with worse balance, falls, and greater reported mobility limitations. Here, we use tracking devices to measure physical activity and the frequency of out-of-home travel in the daily lives of subjects with age-related macular degeneration (AMD).

**Methods:** Control subjects with normal vision and AMD patients between 60-80 years were recruited. AMD patients had evidence of bilateral drusen, geographic atrophy, or choroidal neovascularization with bilateral VA loss to 20/32 or worse, or unilateral VA loss to 20/200 or worse. Physical activity over 1 week was monitored in terms of steps with an accelerometer. Out-of-home travel was monitored with a cellular network based tracking device.

**Results:** 37 controls and 28 AMD patients provided an average of 6.7 +/- 1.0 days of complete tracking data. Controls were younger than AMD subjects (69.9 vs. 74.1 years,  $p = .002$ ) and more often non-white ( $p = .005$ ). No group differences were found in gender, education, employment, cognition, or comorbid illnesses (all  $p > .2$ ). Mean logMAR VA in the better eye was 0.04 +/- 0.12 for controls and 0.51 +/- 0.43 for AMD patients ( $p < .001$ ).

The median control subject walked 5,510 steps/day (IQR=3,455 to 7,454) while the median AMD subject walked 3,085 steps/day (IQR=2,011 to 6,096). In multivariable models, AMD patients with a better-eye VA less than 20/60 walked 43% less than controls ( $p = 0.046$ ), and each one-line drop in VA was associated with a 6.1% decrease in daily steps (95% CI: 0 to 12%,  $p = 0.043$ ). AMD patients were significantly more likely to be in the lowest tertile of daily steps taken (OR=5.8 for taking under 2930 steps/day;  $p = .037$ ; 95% CI: 1.1 to 30.7).

With regards to travel outside the home, the median control subject made 1.33 excursions/day (IQR=1.00 to 1.57), while the median AMD patient made 1.00 excursions/day (IQR=0.64 to 1.31). In multivariable models, AMD patients more often made 1 or fewer excursions/day as compared to controls (OR=3.5;  $p = 0.056$ ; 95% CI: 0.97 to 12.7), with even higher odds noted for AMD patients with better-eye VA less than 20/60 (OR=6.8;  $p = 0.029$ ; 95% CI: 1.2 to 37.8).

**Conclusions:** Many AMD patients restrict physical activity to levels far below recommended guidelines and also limit travel outside the home. The substantial impact of AMD on mobility outcomes demonstrates the importance of vision-preserving treatments, and highlights the need for mobility training to help maintain adequate levels of activity.

**Commercial Relationships:** Emilie S. Chan, None; Chad Hochberg, None; Eugenio Maul, None; Luigi Ferrucci, None; David S. Friedman, None; Pradeep Y. Ramulu, None

**Support:** NIH Grant EY018595, American Geriatrics Society Dennis W. Jahnigen Award

**Program Number:** 1912 **Poster Board Number:** D870

**Presentation Time:** 1:45 PM - 3:30 PM

**An Environmental and Point of Gaze Investigation of Wayfinding**

Ronald A. Schuchard. VAPAHCS / Stanford University, Palo Alto, CA.

**Purpose:** The study objective was to obtain point of gaze during indoor wayfinding in older adults with and without mild dementia. Wayfinding problems (e.g., an inability to find or recognize a destination) are common among older adults especially those with mild cognitive loss and are related to falls. Wayfinding problems are person-environment problems from deficits in spatial orientation making it difficult to maintain a cognitive map of the route to a desired location, as well as with deficits that impact abilities to plan and carry out goal-directed travel and to ignore irrelevant and distracting stimuli. Optimal wayfinding has the potential to positively impact the independence, safety, and QOL of older adults.

**Methods:** 58 participants (age 65 to 92, 44 with MMSE of 24 or higher, and independent in mobility) followed a 120 ft indoor route marked with content-free, high contrast signs. The signs were placed at 3 heights - near the floor, above the handrail, and just above the existing signage. Participants were instructed to look for and follow the signs. Point of gaze, time, and path errors were recorded. A wireless mobile eye tracking system (ISCAN ETL-410) was used to measure 30 points of gaze per second. Point of gaze was calibrated for each participant before and then validated after each testing session. Participants were screened for visual acuity, contrast sensitivity, visual fields and Mattis Dementia Rating Scale (DRS). How many and which of the test signs subjects looked at was also recorded.

**Results:** All participants had normal age-related visual function. Participant hallway performance included: 1) 49 / 12.1 (mean / SD) seconds to complete the route; 2) looked least often at the upper areas of the hallway walls, the locations for existing signage; 3) Looking down the hallway and at the floor accounted for almost 47% of the point of gaze locations; and 4) looked to the left and right hallway walls below the existing signage about as often as they looked directly down the hall. The hallway walls below the handrail and at the floor directly in front of them accounted for 54% of the point of gaze locations. Few subjects swept their gaze from left to right and back. Participants looked at bottom signs more often (53%) than middle or top signs combined. Participants who had lower MMSE

scores (below 24) had more errors/redirects during wayfinding and took longer to complete the route.

**Conclusions:** Our results provide evidence that wayfinding information is not located where older adults most often look while wayfinding. The findings suggest that providing wayfinding information that is easy to see and placing it in locations they routinely look at while ambulating can improve wayfinding performance.

**Commercial Relationships:** Ronald A. Schuchard, None

**Support:** VA RR&D Service

**Program Number:** 1913 **Poster Board Number:** D871

**Presentation Time:** 1:45 PM - 3:30 PM

#### **Adaptive Gait Changes due to Ocular Magnification in Older People**

David B. Elliott<sup>1</sup>, Graham J. Chapman<sup>2</sup>, <sup>1</sup>Optometry, University of Bradford, Bradford, United Kingdom; <sup>2</sup>Centre for Health, Sport and Rehabilitation Research, University of Salford, Salford, United Kingdom.

**Purpose:** Intervention trials that reduce visual impairment in older adults have not produced the expected improvements in reducing falls rate. We hypothesised that this may be caused by adaptation problems by older adults due to changes in ocular magnification provided by new spectacles and/or cataract surgery. This study assessed the effects of lens magnification on adaptive gait in young and older adults.

**Methods:** Adaptive gait was measured in 10 young (mean age 22.3 ± 4.6 years) and 10 older adults (mean age 74.2 ± 4.3 years) with the participants' habitual refractive correction (0%) and with size lenses producing ocular magnification of ±1%, ±2%, ±3%, and ±5%. Adaptive gait parameters were measured when participants approached and stepped up onto a single step.

**Results:** Adaptive gait changes in the young and older age groups were similar. Increasing amounts of magnification (+1% to +5%) led to an increased distance of the feet from the step, increased vertical toe clearance and reduced distance of the lead heel position on the step ( $p < 0.0001$ ). Increasing amounts of minification (-1% to -5%) led to the opposite of these changes ( $p < 0.0001$ ).

**Conclusions:** The adaptive gait changes were driven by the magnification changes provided by the size lenses. Steps appeared closer and larger with magnification and further away and smaller with minification and gait was adjusted accordingly. Magnification may explain the mobility problems some older adults have with updated spectacles and after cataract surgery. Adaptation to ocular magnification did not occur in the short term in young or older adults.

**Commercial Relationships:** David B. Elliott, None; Graham J. Chapman, None

**Support:** Federation of Ophthalmic and Dispensing Opticians grant

**Program Number:** 1914 **Poster Board Number:** D872

**Presentation Time:** 1:45 PM - 3:30 PM

#### **Effect Of Aging On Vision And Postural Stability In Chinese Community-dwelling Older People**

Allen M. Cheong<sup>1A</sup>, Bob Cheng<sup>1B</sup>, Frankie Yeung<sup>1B</sup>, Kar Ho Siong<sup>1A</sup>, Andrew Lam<sup>1A</sup>, <sup>A</sup>School of Optometry, <sup>B</sup>Sports Conditioning and Health, Faculty of Health and Social Sciences, <sup>1</sup>The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong.

**Purpose:** Vision deteriorates as we age. Impaired vision may result in substantial adverse effects in balance functions, predisposing older people to falls. Since falls seldom occur during double-leg stance, evaluation of balance control is important to confine to both double-leg and single-leg stance. This study examined the relationship between visual factors and postural stability measured at different compliant conditions among community-dwelling older adults in Hong Kong.

**Methods:** 128 community-dwelling aged 60 to 95 years were recruited from community-dwelling centres using convenience sampling (75.6 ± 7.1 years). Demographic information and history of falls in the previous 3-month were collected. Fear of falling was measured by Activity-related fear of falling using the Activities-Specific Balance Confidence Scale (ABC). Participants' habitual distance and near visual acuity (better eye), contrast sensitivity and stereoacuity were measured by Lea Numbers chart, Melbourne Edge Test and Randot Stereotest respectively. Balance function in terms of postural sway was measured by a swaymeter for a maximum of 15 sec for each condition: 1) stood on firm and compliant foam surfaces; and 2) double-leg and single-leg stance on dominant leg. Area of the displacements of the body at the level of waist for each condition were recorded and computed in terms of log millimeter square per second.

**Results:** Postural stability was significantly deteriorated while standing on a foam surface and on single-leg stance than on a firm surface with double or single-leg stance ( $p < 0.01$ ). Significant age-related declines were found in the postural sway (standing on foam surface with double-leg stance) and vision measures (distance and near acuities, contrast sensitivity,  $p < 0.05$ ). One possible reason for this finding might be attributed to the healthier and active participants recruited in this sample. Demographic summary revealed a lower incidence of falls (8.6% participants reported falls in the past 3-month), higher frequency of regular exercise (82% participants reported having exercise at least 3 times per week), and high self-perceived balance confidence in ABC Scale (mean Balance confidence of 71.2).

**Conclusions:** Vision and postural stability deteriorated due to aging. However the deterioration rate for vision and postural stability could be different, depending on the personal health and engagement in exercise.

**Commercial Relationships:** Allen M. Cheong, None; Bob Cheng,

None; Frankie Yeung, None; Kar Ho Siong, None; Andrew Lam, None

**Support:** Hong Kong Food and Health Bureau, Health Care and Promotion Fund (23090654)

**Program Number:** 1915 **Poster Board Number:** D873

**Presentation Time:** 1:45 PM - 3:30 PM

#### **Can Pedestrians Judge The Time-to-Arrival of Approaching Vehicles?**

Shirin E. Hassan, JulieAnne M. Roper, Nicholas J. Woodall. School of Optometry, Indiana University, Bloomington, IN.

**Purpose:** The aim of this study was to determine how well normally-sighted pedestrians can judge the time-to-arrival of approaching vehicles using either vision and hearing or hearing only.

**Methods:** Twenty-nine normally sighted subjects stood with their eyes closed 0.5m before a curb of an unsignalized street. Subjects wore earbud-style headphones attached to a laptop computer which played white noise. At random times, an audible tone was given, at which time the white noise paused and subjects observed an approaching vehicle for two seconds under one of two sensory conditions: (i) habitual vision and habitual hearing or (ii) masked vision and habitual hearing. During the two second observational time, the habitual vision and habitual hearing subjects opened their eyes such that they could "see" and "hear" the approaching vehicle. The masked vision and habitual hearing subjects kept their eyes closed and so could only "hear" approaching vehicles. At the end of this period a second tone was given, at which time the white noise resumed and subjects closed their eyes and recorded the vehicle's perceived time-to-arrival by pressing a hand held trigger; each trigger press corresponded to the estimation of one second of the vehicle's travel time. The error, computed as the difference between the actual and perceived time-to-arrival, was calculated for each subject under both sensory conditions and an analysis of co-variance was used to determine if the error changed significantly as a function of sensory condition and time-to-arrival.

**Results:** Our preliminary analysis of the data showed that the error changed as a function of time-to-arrival ( $t_{5133}=44.76, p < 0.001$ ). The way in which the error changed as a function of time-to-arrival however was different for the two sensory conditions (time-to-arrival x sensory condition interaction,  $t_{5132}=-13.55, p < 0.001$ ). We found that with increasing time-to-arrival, the amount of under-estimation of the actual time-to-arrival was greater under the hearing only condition than it was under the vision and hearing condition.

**Conclusions:** Our data suggests that the further away the vehicle was from the pedestrian, the greater the inaccuracy at judging the time-to-arrival. Pedestrians tended to under-estimate the time-to-arrival of approaching vehicles by a greater amount when using only auditory information compared to using both vision and hearing.

**Commercial Relationships:** Shirin E. Hassan, None; JulieAnne M. Roper, None; Nicholas J. Woodall, None

**Support:** NIH Grant: T35-EY013937

**Program Number:** 1916 **Poster Board Number:** D874

**Presentation Time:** 1:45 PM - 3:30 PM

#### **Demographics of Bioptic Drivers in Illinois**

Matthew J. Twardowski<sup>1,2</sup>, Eliot Masek<sup>1,2</sup>, John D. Coalter<sup>2</sup>, Walter M. Jay<sup>3</sup>. <sup>1</sup>Low Vision and Ocular Disease, Illinois Eye Institute, Chicago, IL; <sup>2</sup>Spectrios Institute for Vision Rehabilitation, Wheaton, IL; <sup>3</sup>Ophthalmology, Loyola University of Chicago, Maywood, IL.

**Purpose:** Bioptic driving is a method of driving that utilizes both the patient's spectacle vision in combination with intermittent spotting through a small bioptic telescopic lens attached to the patient's spectacle. Over 40 states permit low vision patients to use bioptics to pass the vision requirements for driving. In Illinois, bioptic drivers are initially approved to drive only during the day, but after one year, may apply for night driving privileges. We utilized a phone survey to determine the demographics of bioptic drivers in Illinois.

**Methods:** 34 of 50 patients who had undergone a driving evaluation and purchased bioptics at the Spectrios Institute responded to an IRB-approved telephone survey (19 males, 15 females). Patients were selected from a list of potential bioptic drivers from 2004 to 2010.

**Results:** The average age of the subjects was 63.9 years and the range was 18-86. There were 15 different diagnoses with ARMD (9), optic atrophy (4), glaucoma (3), and ocular albinism (3) the most common. Of the 34 subjects, 30 (88%) were still driving. The average length of driving with the bioptic was 4.52 years (range 4 months to 20 years). The main motivation behind driving was independence (82%) followed by employment (24%). Of the 30 still driving, 19 (63%) drove daily, 6 (20%) drove 3-5x/week. Of the current drivers, 63% drove less than 10 miles per trip. 12 of the 30 drivers stated they would drive on all road types including expressways. 26 of 30 stated they usually drive alone. 13 of 30 used GPS navigation systems. 17 of 30 rarely or never drove at night, while 18 of 30 passed a night road test. 4 of the 34 (11%) were involved in an accident. 7 of the 34 (21%) had received a moving violation.

**Conclusions:** In Illinois, many low vision patients with a wide variety of ophthalmologic diagnoses are successfully driving. Many are gainfully employed. The accidents and moving violations for the subjects studied did not point to a general public safety concern regarding bioptic drivers.

**Commercial Relationships:** Matthew J. Twardowski, None; Eliot Masek, None; John D. Coalter, None; Walter M. Jay, None  
**Support:** None

**Program Number:** 1917 **Poster Board Number:** D875

**Presentation Time:** 1:45 PM - 3:30 PM

#### **Bioptic Driving Training and Road Testing**

Bradley E. Dougherty, Thomas W. Raasch, Roanne E. Flom, Mark A. Bullimore. College of Optometry, Ohio State University, Columbus, OH.

**Purpose:** In approximately 40 states, drivers with low vision who cannot meet vision standards with conventional optical correction are permitted to use bioptic telescopic spectacles (BTS) to obtain licensure. BTS are spectacles with telescopes mounted superiorly, designed to allow low vision drivers to identify signs and other objects at a greater distance. The purpose of this investigation was to examine visual and demographic factors, and their relationship to training hours and road test results.

**Methods:** A retrospective review of records of patients who completed an initial bioptic examination at the College of Optometry at the Ohio State University was initiated. Patients were identified by CPT code in the College's patient record system. Data were collected on vision including visual acuity (logMAR charts), contrast sensitivity (Pelli Robson or Mars charts), visual field (arc perimeter or Goldmann), and glare sensitivity and recovery (BAT). Demography, ocular diagnosis, licensure history, and driver training and testing for licensure with BTS were also recorded. Relationships between hours of training before the driving instructor judged the patient ready for a road test and vision data and road testing results were investigated evaluated with linear and logistic regression and ANOVA.

**Results:** Fifty patients (28 males) were identified as having completed an initial vision examination, with 34 reporting some prior form of licensure. Age at initial exam ranged from 17 to 78 years (mean = 39±14 years). Of the 50 patients, 34 (68%) were documented as having subsequently passed a road test and received a license to drive with BTS. Of all patients with documented training and road test reports (n=26), 23% failed a road test at least once. Higher age was related to having failed a road test (p=.036). The mean (±SD) number of hours of training prior to road testing was 17±16. Higher total hours of training was related to decreased horizontal visual field (p = 0.018), lack of previous licensure (p = 0.027) and test type (daylight vs. night) (p = 0.027). Common errors on road testing included "improper steering - erratic, weaving" (32% of patients), "improper braking" (32%), "drives too fast/slow for conditions" (21%), and "turns too wide/short" (16%).

**Conclusions:** Approximately 2/3 of those who presented for an initial exam eventually received licensure. Several patient factors were related to the amount of training patients received before road testing.

**Commercial Relationships:** Bradley E. Dougherty, None; Thomas W. Raasch, None; Roanne E. Flom, None; Mark A. Bullimore, None

**Support:** Supported by NEI T32-EY013359 and American Optometric Foundation Merton C. Flom Ezell Fellowship

**Program Number:** 1918 **Poster Board Number:** D876

**Presentation Time:** 1:45 PM - 3:30 PM

#### **Assessing Driving in Older Adults: Information Being Obtained by Vision Care Providers**

David C. Musch<sup>1A</sup>, Nancy K. Janz<sup>1B</sup>, Rebecca L. Leinberger<sup>1B</sup>, Leslie M. Niziol<sup>1C</sup>, Brenda W. Gillespie<sup>1D</sup>. <sup>A</sup>Ophthalmology & Visual Sciences, and Epidemiology, <sup>B</sup>Health Behavior & Health Education, <sup>C</sup>Ophthalmology & Visual Sciences, <sup>D</sup>Biostatistics, <sup>1</sup>University of Michigan, Ann Arbor, MI.

**Purpose:** To describe the tests and information vision care providers (VCPs) most often use to assess driving capabilities of their elderly patients.

**Methods:** We developed a survey of VCPs' attitudes and actions taken in assessing driving capabilities among their elderly patients. The survey was based on a conceptual model of health behavior, prior studies, and advice from content experts. Membership lists of the Michigan Society of Eye Physicians and Surgeons and the Michigan Optometric Association were used to identify a stratified random sample of 500 VCPs. Methods to maximize return rate were employed, yielding a response rate of 83% (415/500). Upon removing ineligible VCPs (n=7) and surveys returned blank (n=4), surveys from 404 VCPs (81%) were analyzed. Regression analyses were performed to identify associations with responses.

**Results:** Based on responses of "often" or "always", the vision tests that VCPs reported to be most frequently used in assessing driving capabilities included visual acuity (99%), peripheral vision (82%), and visual field (66%). VCPs less frequently considered other medical conditions (49%) and medications that might affect driving (33%). Inquiries by VCPs about night driving, reading signs, and glare were very common (≥87%), whereas questioning about other driving challenges (merging, making left turns, and backing up) and the patient's recent driving record were infrequent (<10%). Other than asking if patients wear their corrective lenses when driving (71% often/always), the VCPs usually did not inquire about other external conditions or resources [e.g., availability of a "co-pilot" (18%) or alternative transportation (23%)], nor did they usually ask about driving frequency or distance (20%). VCP characteristics that increased the likelihood of seeking driving information included female gender, younger age, and general practice (vs. specialization).

**Conclusions:** Key data that would enable VCPs to better assess their elderly patients' problems with driving and to more effectively advise them on adjustments that may be necessary are often not obtained.

**Commercial Relationships:** David C. Musch, None; Nancy K. Janz, None; Rebecca L. Leinberger, None; Leslie M. Niziol, None; Brenda W. Gillespie, None

**Support:** Michigan Center for Advancing Safe Transportation Throughout the Lifespan

**Program Number:** 1919 **Poster Board Number:** D877

**Presentation Time:** 1:45 PM - 3:30 PM

#### **Realistic Simulation of Human Contrast Perception after Exposure to Frontal Headlight Glare in Driving Simulations**

Benjamin Meyer<sup>1</sup>, Clemens Grunert<sup>2</sup>, Sebastian Thomschke<sup>2</sup>, Mark Gonter<sup>2</sup>, Mark Vollrath<sup>3</sup>, Marcus Magnor<sup>1</sup>. <sup>1</sup>Computer Graphics Lab, Braunschweig, Germany; <sup>2</sup>Volkswagen Research, Wolfsburg, Germany; <sup>3</sup>Department of Engineering and Traffic Psychology, Braunschweig, Germany.

**Purpose:** Computer-based night driving simulations are used in the automobile industry to evaluate the illumination of the street both for novel lighting functions and the design of new headlights. To be able to draw conclusions from these test results, it is indispensable for the visual quality of the simulation to be perceptually realistic.

The aim of this work is to simulate the experience of glare effects in a night driving simulator by adjusting the display contrast according to human perception.

**Methods:** As contrast perception is highly subjective, we performed a psychophysical experiment and reconstructed night driving conditions as authentic as possible. This included background illumination as well as a representative driving situation, permitting realistic driving behavior. The subjects were blinded by a real headlamp and their contrast perception was monitored. Averaging the test results of 18 subjects yielded time response curves of contrast perception, depending on the duration and intensity of the glare. In addition, we determined the minimal perceivable contrast in an illuminated office on the future simulation hardware, exemplary for one fully adapted user. Given our measurements, we are now able to match the histograms of gray values of the visualization to the perceived minimal contrast.

**Results:** From experimentally determined contrast perception curve, the visualization of the driving simulator is darkened abruptly after a simulated glare to reduce contrast perception. Over time, the visualization is lightened up again, until full contrast perception is restored (see figure).

**Conclusions:** Our night drive simulator enables us to simulate the re-adaptation of the human visual system after a short glare, without the need to emulate authentic illumination. This allows for the analysis under predefined laboratory conditions of critical traffic situations involving glare effects.



**Commercial Relationships:** Benjamin Meyer, Volkswagen AG (F); Clemens Grunert, Volkswagen AG (E); Sebastian Thomschke, Volkswagen AG (E); Mark Gonter, Volkswagen AG (E); Mark Vollrath, None; Marcus Magnor, None

**Support:** None

**Program Number:** 1920 **Poster Board Number:** D878

**Presentation Time:** 1:45 PM - 3:30 PM

#### **Visual Performance In Night Driving For Normal And Cataract Subjects**

Carolina Ortiz, Cristina Pérez, José R. Jiménez, José J. Castro, Rosario G. Anera. Optics, University of Granada, Granada, Spain.

**Purpose:** Aging and several pathological conditions such as cataracts increase ocular scattering and thereby diminish visual function, and this can be considered a risk factor in driving, particularly at night. We examine the visual performance and optical quality in night driving for younger drivers as well as for older drivers (with and without cataract).

**Methods:** A total of 29 subjects who did not have a cataract in either eye (20 younger and 9 older drivers) and 8 older adults with cataract in one or both eyes were included in this study. In the younger age group, 20 subjects were tested with an average of 24.8±2.6 years (19-29 years), and the older group (>60 years)

consisted of 9 healthy drivers and 8 drivers with cataracts, averaging 72.4±7.2 years of age. Despite the cataract, the visual acuity with the best correction was >0.5 in all eyes. Subjects were examined for distance high-contrast visual acuity (VA), contrast sensitivity, disturbance index (halos) with a Halometer test, and optical quality (Strehl ratio). Subjects also completed a subjective Driving Habits Questionnaire (DHQ), designed to provide information on their driving during the past year.

**Results:** The Strehl ratio indicates worse optical quality for older drivers, being significantly ( $P<0.05$ ) lower than the Strehl ratio for young drivers. The CSF for older drivers was also significantly lower than that for the young drivers ( $P<0.05$ ). The Disturbance index increased with the age of the driver. All the parameters studied showed a deterioration in visual performance and optical quality for the drivers with cataract, reflecting greater difficulty in driving, especially at night, even when having good visual acuity.

**Conclusions:** It is advisable, in addition to measuring visual acuity and contrast sensitivity, to use new tests that are quick and objective in measuring age-associated visual deterioration and performance and that can be considered a risk factor in night-time driving.

**Commercial Relationships:** Carolina Ortiz, None; Cristina Pérez, None; José R. Jiménez, None; José J. Castro, None; Rosario G. Anera, None

**Support:** This research was supported by Ministerio de Educación y Ciencia (Spain) grant FIS2009-07482 and Junta de Andalucía (Spain) grants P06-FQM-01359 and P07-FQM-02663.

**Program Number:** 1921 **Poster Board Number:** D879

**Presentation Time:** 1:45 PM - 3:30 PM

**Aging Change of Retinal Image Contrast in the Eyes with Transparent Lenses of Japanese**

Norihiro Mita<sup>1A</sup>, Natsuko Hatsusaka<sup>1A</sup>, Eri Shibuya<sup>1A</sup>, Yasuo Sakamoto<sup>1A,2</sup>, Nami Yamamoto<sup>2</sup>, Hiroshi Sasaki<sup>1A,1B</sup>, <sup>A</sup>Department of Ophthalmology, <sup>B</sup>Division of Vision Research for Environmental Health, <sup>1</sup>Kanazawa Medical University, Uchinada, Japan; <sup>2</sup>Visual Science Course, Tohoku Bunka Gakuen University, Sendai, Japan.

**Purpose:** To investigate the aging change of retinal image contrast in eyes with transparent lenses of Japanese population.

**Methods:** Subjects comprised right eyes of 269 Japanese (mean age 39.7 years; 23 in age 20s, 118 in 30s, 95 in 40s and 33 in 50s) with no organic disease other than refractive error and with over 0logMAR best corrected visual acuity. A point spread function analyzer (PSF-1000, TOPCON) was used to measure sensitivity of retinal images under condition of best corrected refractive error, through Landolt ring simulation with 3 mm pupils. An anterior segment analysis system (EAS-1000, NIDEK) was used to measure backward light scattering intensity (LSI) and optical distance (mm) of each layer of lens (anterior capsule (A), anterior adult nucleus (B) and central inner layer (C)). Lens transparent property (LTP), an index we introduced previously (Sasaki H, et al: Ophthalmic Res. 1999), was used to estimate lens transparency. It is determined by:  $LTP = LSI \text{ at } A + LSI \text{ at } B \times \text{optical distance (mm) between A and B} + LSI \text{ at } C \times \text{optical distance (mm) between A and C}$ . We also evaluated higher order aberrations ( $\mu\text{m}$ ) with 4 mm pupils by wavefront analyzer (9000PW, TOPCON). Examinations were performed under maximal mydriasis.

**Results:** Retinal image contrast degenerated significantly with aging. The largest difference was seen with optotype 0.423logMAR which is in the intermediate frequency range. The retinal image contrast reduced by 5.4% in 10 years. That with optotype 0.423logMAR also degraded remarkably with increase of total higher order aberrations ( $p<0.01$ ) and LTP ( $p<0.01$ ). Multiple linear regression analysis of influencing factors showed the effects of higher order aberration and LTP were almost equal.

**Conclusions:** Retinal image contrast in eyes with transparent lenses degenerated with aging. It was clarified that this age related degradation can be attributed to increase of higher order aberrations and LTP among the Japanese subjects aged from 20s to 60s.

**Commercial Relationships:** Norihiro Mita, None; Natsuko Hatsusaka, None; Eri Shibuya, None; Yasuo Sakamoto, None; Nami Yamamoto, None; Hiroshi Sasaki, None

**Support:** None

**Program Number:** 1922 **Poster Board Number:** D880

**Presentation Time:** 1:45 PM - 3:30 PM

**Changes With Ageing Of Retinal Image Quality In Healthy Population**

Juan Carlos Ondategui Parra<sup>1</sup>, Joan Antoni Martínez-Roda<sup>1</sup>, Meritxell Vilaseca Ricart<sup>2</sup>, Montserrat Aguirre Polo<sup>1</sup>, Anna Giner<sup>2</sup>, Francisco Javier Burgos<sup>2</sup>, Jaume Pujol<sup>2</sup>. <sup>1</sup>Optics and Optometry, Polytechnical Univ of Catalonia, University Vision Centre (CUV), Terrassa, Spain; <sup>2</sup>Optics and Optometry, Polytechnical Univ of Catalonia, Centre for Sensors, Instruments and Systems Development (CD6), Terrassa, Spain.

**Purpose:** To assess the mean changes of Optical Quality (OQ) and, Intraocular Scattering (IS) of the eye with ageing in healthy population. For patients older than 60 years old, to compare the same features between groups of non-operated eyes and those implanted with an IOL in cataract surgery.

**Methods:** We evaluated the retinal image quality in 568 eyes within a group of 298

healthy patients and stratified the sample in four groups of age (G1 18-30 yr, G2 31-45 yr, G3 46-60 yr, G4 61-91 yr). Patients included in the study did not report any ocular alteration. However, in group G4 subjects undergoing cataract surgery implanted with an IOL, were also considered. Their best spectacle-corrected visual acuity (BSCVA) was 20/20 (20/36 for G4) or better assessed with a standard logMAR chart. Retinal images were acquired with a clinical double-pass (DP) instrument (OQAS, Visiometrics, Spain) using a 4-mm exit pupil diameter. From the DP images, several parameters related with the OQ of the eye (MTF, Strehl ratio (SR) and OQAS values (OV) at contrasts 100%, 20% and 9% and with the IS (Objective Scatter Index, OSI) were obtained.

**Results:** 46.67% of patients included in the study were men. Mean age (yr ± SD) was: G1 22±3, G2 38±3, G3 52±4 and G4 77±9. Mean logMAR BSCVA was: G1 -0.09±0.12, G2 -0.16±0.11, G3 -0.14±0.09 and G4 -0.03±0.11. OQ and IS parameters were for non-operated eyes (G1, G2, G3, G4): SR (0.24±0.07, 0.23±0.06, 0.20±0.05, 0.12±0.04), OV100% (1.33±0.31, 1.35±0.28, 1.28±0.24, 0.69±0.34) OV20% (1.37±0.41, 1.37±0.35, 1.24±0.36, 0.62±0.31) OV9% (1.39±0.49, 1.35±0.41, 1.16±0.36, 0.61±0.30) and OSI (0.50±0.51, 0.48±0.26, 0.61±0.27, 1.41±0.91) and SR 0.12±0.04; OV100% 0.65±0.3, OV20% 0.62±0.31, OV9% 0.61±0.26 and OSI 1.87±1.49 for eyes implanted with an IOL. Results showed a statistically significant increase of the IS ( $P<0.01$ ) and decrease in OV parameters with age. Statistically significant differences were also found between non-operated eyes and those implanted with an IOL (G4) for the OSI parameter, meanwhile other OQ parameters remained similar.

**Conclusions:** We obtained values of OQ and IS in healthy population with a DP system in a clinical environment, and analyzed the corresponding changes with ageing. Results showed that IS is the parameter with a more marked change with age. However, all parameters of OV also had significant changes.

**Commercial Relationships:** Juan Carlos Ondategui Parra, None; Joan Antoni Martínez-Roda, None; Meritxell Vilaseca Ricart, None; Montserrat Aguirre Polo, None; Anna Giner, None; Francisco Javier Burgos, None; Jaume Pujol, Visiometrics (P)

**Support:** Ministerio de Educación y Ciencia, Spain (Grant DPI2008-06455-C02-01); Ministerio de Asuntos Exteriores y de Cooperación, Spain (Grant D/017822/08) and Visiometrics