Contrast sensitivity in the periphery as a function of defocus

View Session Detail | Print Abstract

Posterboard #: B0101

Abstract Number: 202 - B0101

Author Block: *Robert Rosen[1] , Silvestre Manzanera[2] , Patricia A. Piers[1] , Pablo Artal[2]*
[1] R&D, Abbott Medical Optics, Groningen, Netherlands; [2] Universidad de Murcia, Laboratorio de Optica, Murcia, Spain

Disclosure Block:Robert Rosen, Abbott Medical Optics (Code E (Employment)); Silvestre Manzanera, Abbott Medical Optics (Code F (Financial Support)); Patricia A. Piers, Abbott Medical Optics (Code E (Employment)); Pablo Artal, Abbott Medical Optics (Code C (Consultant))

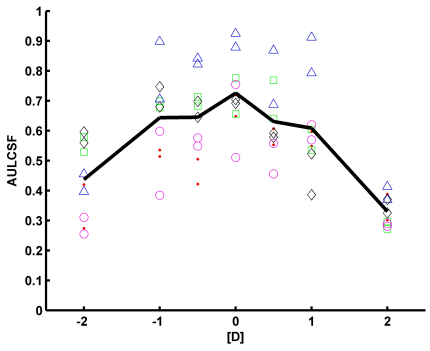
Purpose:Peripheral vision, as measured by the useful field of view test, is the best predictor of driving ability and crash risk and is superior to e.g. visual acuity and contrast sensitivity in the fovea. In addition, peripheral visual ability contributes to awareness, navigation and sports performance. Both neural and optical factors limit peripheral vision, by decreased density of ganglion cells and cones and through oblique astigmatism, coma and relative peripheral defocus. It is known that high contrast visual acuity (VA) is sampling limited and relatively insensitive to peripheral optical errors. However, VA is mostly indicative of reading ability, and typical peripheral tasks involve objects with lower contrast. In this study, through focus contrast sensitivity functions (CSF) in the periphery was measured.

Methods:A monocular adaptive optics visual simulator was used to measure contrast sensitivity in the 25 degrees temporal field of the right eye of five subjects with age of 31±6 years. Astigmatism was corrected and defocus induced with a Badal stage at 0, ± 0.5, ±1 and ±2 D. We used a quick-CSF procedure adapted for peripheral vision with 100 trials and two measurements for each subject at each defocus value. The peripheral CSF was quantified into a single value using the area under the log CSF (AULCSF).

Results:The through-focus AULCSF results is depicted in Figure 1. The intra-subject variability was a standard deviation of 0.05 AULCSF whereas the inter-subject standard deviation was 0.11 AULCSF. The impact of defocus on peripheral vision was larger for larger errors: when going from an absolute error of 1 to 2 D the average loss was 0.24 AULCSF whereas the average loss from 0 to 1 D was only 0.1 AULCSF.

Conclusions:Peripheral contrast sensitivity suffers a marked decrease with large optical errors. Increasing defocus from 1 to 2 D results in a loss of 38% of the remaining AULCSF. Conversely, going from 0 to 1 D only decreases the AULCSF by 14%. This might be due to a depth of focus induced by higher order aberrations as well as the best focus being at another position than what Zernike-based refraction metrics indicate. These results show the importance of not having too large peripheral optical errors that could affect driving safety.

Layman Abstract (optional): Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated details.:



Visual impact of artificially induced intraocular scatter with a liquid crystal phase modulator

View Session Detail | Print Abstract

Posterboard #: B0114

Abstract Number: 215 - B0114

Author Block: *Augusto Arias Gallego[1] , Alexandros Pennos[1] , Harilaos S. Ginis[1] , Pablo Artal[1]*
[1] Laboratorio de Óptica, Universidad de Murcia, Murcia, Spain

Disclosure Block:Augusto Arias Gallego, None; Alexandros Pennos, None; Harilaos S. Ginis, None; Pablo Artal, None

Purpose:Various ocular pathologies, including cataracts, increase the amount of intraocular scattering, which impairs visual function. We developed a procedure to induce realistic and controlled intraocular scatter investigating its impact on Contrast Sensitivity Function (CSF) at the presence of glare.

Methods:The instrument introduces phase masks with controlled spatial properties at the eye's pupil plane. It is based on the use of a liquid crystal on silicon spatial light modulator (LCOS-SLM) conjugated to the pupil plane of the eye by means of a telescope with angular magnification of 6. This setup allows to induce phase structures at the pupil plane with a high resolution (1.3-µm) while providing a field of view of 27 degrees. Subjects viewed monocularly through the system visual stimuli with size of 8 degrees. All experiments were performed with quasi-monochromatic light at 550±40 nm. CSF was measured for different amounts of induced scatter with and without a glare source consisting of a fluorescent ring lamp with equivalent angle radius of 5.6 degrees.

Results:The phase introduced at the pupil plane was calculated to produce a wide-angle point spread function (PSF) similar to the CIE (Commission internationale de l'éclairage) glare function. The amplitude of the generated phase mask controled the amount of added scatter. The area under the logarithm of the CSF (AULCSF) used as a metrics decreased linearly with the amount of induced scatter (straylight parameter S).

Conclusions:A instrument to induced non-invasively and realistically controlled amounts of scatter has been developed. It also permitted to establish the relationship between stray-light and contrast reduction under normal viewing and glare conditions.

Layman Abstract (optional): Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated details.:

Comparison of iPad-Based Visual Function Tests for the Detection of Early Manifest Glaucoma

View Session Detail | Print Abstract

Abstract Number: 2277

Author Block: *Meredith Kim[1] , Aiai Ren[3] , Peter Bex[4] , Matthew Gardiner[3,2] , Carolyn Kloek[3,2] , Peggy Chang[3,2] , Lucy Shen[3,2] , Angela Turalba[3,2] , Louis R. Pasquale[3,2] , Brian J. Song[3,2]*

[1] George Washington University School of Medicine, Washington, District of Columbia, United States; [2] Ophthalmology, Harvard Medical School, Boston, Massachusetts, United States; [3] Ophthalmology, Massachusetts Eye and Ear Infirmary, Boston, Massachusetts, United States; [4] College of Science, Northeastern University, Boston, Massachusetts, United States

Disclosure Block:Meredith Kim, None; Aiai Ren, None; Peter Bex, Co-inventor on a patent for QCSF (Code P (Patent)), Equity in Adaptive Sensory Technology (Code I (Personal Financial Interest)); Matthew Gardiner, None; Carolyn Kloek, None; Peggy Chang, None; Lucy Shen, None; Angela Turalba, None; Louis R. Pasquale, None; Brian J. Song, None

Purpose:To determine the sensitivity, specificity, positive and negative predictive values of frequency doubling technology (FDT) and three iPad-based tests of visual function for the detection of early manifest glaucoma.

Methods:76 eyes of 76 patients with early manifest glaucoma and 13 eyes of 13 age-matched controls were recruited from the Massachusetts Eye and Ear Infirmary between April 2014 and October 2015. All subjects underwent four tests at the same clinic visit in random order: FDT, visualFields easy iPad app, blue arc entoptic phenomenon testing, and quick contrast sensitivity function (QCSF) testing. Sensitivity, specificity, positive and negative predictive values were calculated for all tests. Receiver operating characteristic (ROC) curves were plotted for the area under the log contrast sensitivity function (AULCSF) as well as the contrast sensitivity function acuity (CSF Acuity) of the QCSF test.

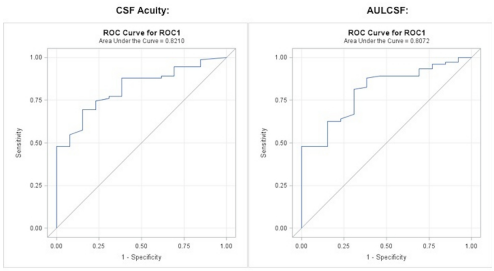
Results:Mean age of all patients was 65.4±11.3 years; 38% male, 74% Caucasian, and 79% phakic. There were no significant differences in baseline demographics between glaucoma and control patients (P>0.05 for all characteristics). Sensitivity, specificity, positive and negative predictive values of each of the four tests is shown in the Table. Optimal cut-off values based on the Youden index for CSF Acuity and AULCSF were 18.3 and 1.78, respectively. Areas under the ROC curves for detection of early manifest glaucoma using CSF Acuity and AULCSF from the QCSF test were 0.82±0.05 and 0.81±0.06, respectively (Figure).

Conclusions:The iPad-based QCSF test has similar sensitivity and specificity as the FDT for the detection of early manifest glaucoma. The QCSF test also has the advantage of being fixation independent. As remote eye disease detection and screening become more prevalent, effective telemedical visual function tests have the potential to become significant adjunctive components of glaucoma evaluations in the future.

Layman Abstract (optional): Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated details.:

	SENSITIVITY	SPECIFICITY	PPV	NPV
FDT	0.84 (0.73-0.91)	0.77 (0.46-0.95)	0.95 (0.87-0.99)	0.45 (0.24-0.68)
QCSF				
• CSF ACUITY	0.69 (0.59-0.80)	0.85 (0.65-1.0)	0.96 (0.91-1.0)	0.32 (0.17-0.48)
• AULCSF	0.81 (0.73-0.90)	0.69 (0.44-0.94)	0.94 (0.88-1.0)	0.39 (0.19-0.59)
EASYFIELD	0.70 (0.58-0.80)	0.31 (0.09-0.61)	0.85 (0.74-0.93)	0.15 (0.04-0.34)
BLUE ARC	0.83 (0.73-0.91)	0.23 (0.05-0.54)	0.86 (0.76-0.93)	0.19 (0.04-0.46)

Mean values with 95% confidence intervals for various tests to detect glaucoma. Quick contrast sensitivity function (QCSF), Contrast sensitivity function acuity (CSF Acuity), area under the log CSF (AULCSF), frequency doubling technology (FDT), visualFields easy iPad app (Easyfield), blue arc entoptic phenomenon (Blue Arc). PPV=positive predictive value; NPV=negative predictive value.,



Receiver operating characteristic curves for: CSF Acuity (Left) and AULCSF (Right).

Reliability of Quick Contrast Sensitivity Function Testing in Adults without Ocular Disease and Patients with Retinitis Pigmentosa

View Session Detail | Print Abstract

Posterboard #: B0115

Abstract Number: 616 - B0115

Author Block: *Manonmani Murugappan[1] , Jeslyn Vayalil[1] , Annette Bade[1] , Ava K. Bittner[1]*
[1] College of Optometry, Nova Southeastern University, Davie, Florida, United States

Disclosure Block:Manonmani Murugappan, None; Jeslyn Vayalil, None; Annette Bade, None; Ava K. Bittner, None

Purpose:To determine the reliability and range of results for area under the log contrast sensitivity function (AULCSF) measures obtained with the quick contrast sensitivity function (qCSF) test in adults without eye disease and those with retinitis pigmentosa (RP).

Methods:Nineteen RP patients and 39 adults with normal visual acuity (VA better than 20/25) and no ocular disease repeated qCSF testing at two sessions within ~1 week binocularly and monocularly, as well as with a NoIR 4% transmission filter to simulate low illumination in the eye with better VA for normals and binocularly for RP patients.

Results:Compared to younger subjects aged 20-59 years (mean AULCSF 1.84, 1.56 or 0.97 for qCSF testing binocularly, with the better eye or filter, respectively), participants between the ages of 60-89 had highly statistically significantly reduced AULCSF measures (mean 1.56, 1.24 or 0.71; all $p \leq 0.001$). When evaluating the difference in monocular AULCSF with versus without the filter, normals aged 70-89 years had a significantly greater reduction by 23% than subjects aged 20-49 years (95%CI:11-34%; $p < 0.001$), likely mediated by natural rod sensitivity loss with aging. Across all normals, mean coefficients of variation (CoV) for AULCSF were 3%, 5% and 10%, while 95% coefficients of repeatability (CR.95) were 0.17, 0.25 and 0.29 log units when testing binocularly, with the better eye and filter, respectively; whereas in RP subjects, mean CoVs for AULCSF were 7%, 12% and 9%, while CR.95 were 0.15, 0.29 and 0.19 log units for binocular, monocular and filter testing, respectively. Reliability metrics in normals and RP will also be presented for CSF acuity and at specific spatial frequencies.

Conclusions:As noted in several previous studies, we measured an age-related decline in photopic qCSF, along with scotopic declines among people in their 70's. The qCSF test provides reliable results across younger and older adults with normal vision, as well as in RP patients, and may be used as a precise outcome measure during clinical trials.

Layman Abstract (optional): Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated details.:

Evaluation of contrast sensitivity function in individuals with Fabry disease

View Session Detail | Print Abstract

Posterboard #: B0117

Abstract Number: 618 - B0117

Author Block: *Pinakin G. Davey[1] , Kaydee McCray[1]*
[1] College of Optometry, Western University of Health Sciences, Pomona, California, United States

Disclosure Block:Pinakin G. Davey, None; Kaydee McCray, None

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

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

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

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

Layman Abstract (optional): Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated details.:Fabry disease is a multi-system disorder that affects all majore organs including the eye. In the eye they have deposits in the front of the eye that may be visible as a small haze or may not even be visible. It was believed that Fabry patients do not have any vision problems due to this deposit. Individuals with Fabry disease often complaint of glare and difficulty of seeing in dim lit environment. The results of this study identify and explain why this may be. Knowing what is causing the problem helps in and what part of the vision is affected. Doctors now can examine contrast sensitivity in Fabry patients and choose appropriate lenses and filters to alleviate their problems.

Figure 1

Parameter	Fabry group	Healthy group
AULCSF*	**2.12 ± 0.27**	**2.23 ± 0.23**
CS acuity cpd	1.44 ± 0.11	1.47 ± 0.10
CS at 1 cpd*	**1.78 ± 0.15**	**1.83 ± 0.12**
CS at 1.5 cpd*	**1.82 ± 0.15**	**1.87 ± 0.12**
CS at 3 cpd*	**1.80 ± 0.16**	**1.87 ± 0.13**
CS at 6 cpd*	**1.57 ± 0.22**	**1.66 ± 0.19**
CS at 12 cpd	1.04 ±0.30	1.15 ± 0.28
CS at 18 cpd	0.61 ±0.35	0.72 ± 0.31

Where

AULCSF is area under log contrast sensitivity function

CSF acuity is high spatial frequency cutoff

CS is contrast sensitivity

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

Altered pattern of 1st and 2nd order visual processing after mild traumatic brain injury in humans

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Abstract Number: 4746

Author Block: *Daniel P. Spiegel[1] , Alexandre Reynaud[1] , Tatiana Ruiz[1] , Maude Laguë-Beauvais[2] , Robert Hess[1] , Reza Farivar[1]*

[1] Ophthalmology, McGill University, Montreal, Quebec, Canada; [2] The Research Institute of the McGill University Health Center, Montreal, Quebec, Canada

Disclosure Block:Daniel P. Spiegel, None; Alexandre Reynaud, None; Tatiana Ruiz, None; Maude Laguë-Beauvais, None; Robert Hess, None; Reza Farivar, None

Purpose:Traumatic brain injury (TBI) is one of the most common causes of disability among the North American population. One of the most often complaints of TBI patients are visual deficits, including blurry vision and increased motion and light sensitivity. We have assessed visual function in TBI patients by estimating the full contrast sensitivity function (CSF) for both static and dynamic 1st and 2nd order stimuli. Our approach—normalizing the 2nd order stimuli by the first order input—allowed us to accurately measure alterations in 2nd order contrast perception that are independent of 1st order performance. Our study provides a unique dataset describing the effects of TBI on fundamental aspects of visual processing.

Methods:A group of 26 mild TBI patients (mean age 34.69 years, 9 males) was recruited for the study. The participants were tested with the modified quick CSF (qCSF) method on five conditions: 1st order static and motion stimuli, and 2nd order orientation-defined, motion-defined, and contrast-defined stimuli. The outcome variables were estimates of qCSF parameters for each condition, namely CSF peak sensitivity (maximum gain), peak spatial frequency, bandwidth, and cut-off spatial frequency. These estimates were compared with a normative dataset of 102 healthy participants.

Results:The three most notable results emerged: (1) we found a significantly higher sensitivity for the 1st order motion stimuli, (2) TBI patients' sensitivity to 2nd order orientation- and contrast-modulated stimuli was lower, and (3) TBI patients' sensitivity was shifted towards higher spatial frequencies for 1st order motion and orientation, and 2nd order contrast-modulated stimuli, as assessed by the peak spatial frequency estimates.

Conclusions:In general, our findings are in agreement with the real-life visual complaints of TBI patients, in particular the increased motion sensitivity and blurry vision. We discuss these findings in terms of an altered pattern of cortical excitation and inhibition after TBI. The shift of contrast sensitivity functions towards larger spatial frequencies is intriguing, however, it is consistent with previous reports indicating that cortical lesions may predominantly affect processing of lower spatial frequencies. Our results expand the growing body of information about cortically-based visual deficits after mild TBI.

Layman Abstract (optional): Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated details.:

Characterizing monocular and binocular contrast sensitivity in corrected and uncorrected myopia.

View Session Detail | Print Abstract

Posterboard #: D0005

Abstract Number: 5515 - D0005

Author Block: *Hui Wang[1,2] , Luis A. Lesmes[3] , Michael Dorr[4,3] , Zhong-Lin Lu[5] , Tobias Elze[2] , Peter Bex[6]*
[1] Institute for Psychology and Behavior, Jilin University of Finance and Economics, ChangChun, JiLin, China; [2] Schepens Eye Research Institute, Harvard Medical School, Boston, Massachusetts, United States; [3] Adaptive Sensory Technology, Boston, Massachusetts, United States; [4] Institute for Human-Machine Communication, Technische Universität München, Munich, Germany; [5] Department of Psychology, Ohio State University, Columbus, Ohio, United States; [6] Department of Psychology, Northeastern University, Boston, Massachusetts, United States

Disclosure Block:Hui Wang, None; Luis A. Lesmes, Adaptive Sensory Technology (Code E (Employment)), Adaptive Sensory Technology (Code I (Personal Financial Interest)), Adaptive Sensory Technology (Code P (Patent)); Michael Dorr, Adaptive Sensory Technology (Code I (Personal Financial Interest)), Adaptive Sensory Technology (Code P (Patent)); Zhong-Lin Lu, Adaptive Sensory Technology (Code I (Personal Financial Interest)), Adaptive Sensory Technology (Code P (Patent)); Tobias Elze, None; Peter Bex, Adaptive Sensory Technology (Code I (Personal Financial Interest)), Adaptive Sensory Technology (Code P (Patent))

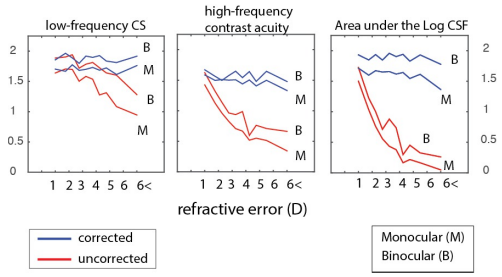
Purpose:The contrast sensitivity function (CSF) provides an important measure of functional vision. Previous research [1] has examined how uncorrected refractive error affects vision at the lower (Pelli-Robson) and higher (Snellen acuity) ranges of spatial frequencies. The purpose of this study was to evaluate monocular and binocular contrast sensitivity (CS) across a broader range of spatial frequencies, in corrected and uncorrected myopia.

Methods:For emmetropes (n=38), three CSFs were collected in monocular (M) and binocular (B) conditions. For myopes (n=63), six CSFs were collected in two M and one B conditions, with and without optical correction. For each observer, the full set of CSFs was collected in only 15-30 min using the quick CSF at a near-to-intermediate viewing distance of 60 cm (1, 3). To compare with previous research, we calculated three contrast sensitivity metrics: (i) low-frequency CS (1 cpd); (ii) AULCSF - area under the log CSF - and (iii) CS acuity the cutoff-frequency at which sensitivity= 0.0. For myopes, analyses of CSF metrics were stratified by self-reported refractive error, ranging between -1.0D and < -6D, respectively. We evaluated test-retest repeatability, and advantage provided by M relative to B vision.

Results:For M vision, there were significant correlations between uncorrected refractive error and both AULCSF and CSF acuity (r=-.68, p<.0001; and r=-.69, p<.0001). In Figure 1, each plot presents patterns of corrected and uncorrected contrast sensitivity in M and B conditions, as a function of refractive error. Relative to low-frequency CS or high-frequency acuity, the AULCSF exhibits the largest dynamic range (1.5 decimal log units) and the steepest decline in visual performance with an increase in uncorrected refractive error. The binocular advantage - the AULCSF difference between B and better M conditions- was the same with and without correction: ~20-.25 log units. Finally, coefficients of reliability (COR) -- ranging from .19-.24 decimal log units – were similar across conditions with and without correction.

Conclusions:CSF testing in mid-range spatial frequencies (and beyond) delivers a comprehensive assessment of visual performance, which is sensitive to the benefits of refraction. This study demonstrates the potential for the CSF to provide a sensitive and precise outcome measure for refractive interventions.

Layman Abstract (optional): Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated details.:


low-frequency CS
high-frequency contrast acuity
Area under the Log CSF
B
M
B
M
2
1.5
1
0.5
0
1 2 3 4 5 6 6<
refractive error (D)
corrected
uncorrected
Monocular (M)
Binocular (B)

A Survey of Contrast Sensitivity in Visual Neuropathology

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Posterboard #: D0127

Abstract Number: 5161 - D0127

Author Block: *Luis A. Lesmes[1] , Peter Bex[2] , Zhong-Lin Lu[3] , Ava K. Bittner[4] , Pradeep Y. Ramulu[6] , Jan-Patrick Stellmann[7] , Michael Dorr[5]*
[1] Adaptive Sensory Technology, Boston, Massachusetts, United States; [2] Department of Psychology, Northeastern University, Boston, Massachusetts, United States; [3] Ohio State University, Columbus, Ohio, United States; [4] College of Optometry, Nova Southeastern University, Ft. Lauderdale, Florida, United States; [5] Technical University of Munich, Munich, Germany; [6] Wilmer Eye Institute, Johns Hopkins University, Baltimore, Maryland, United States; [7] Hamburg-Eppendorf, Hamburg, Germany

Disclosure Block:Luis A. Lesmes, Adaptive Sensory Technology (Code I (Personal Financial Interest)), Adaptive Sensory Technology (Code P (Patent)), Adaptive Sensory Technology (Code E (Employment)); Peter Bex, Adaptive Sensory Technology (Code I (Personal Financial Interest)), Adaptive Sensory Technology (Code P (Patent)); Zhong-Lin Lu, Adaptive Sensory Technology (Code I (Personal Financial Interest)), Adaptive Sensory Technology (Code P (Patent)); Ava K. Bittner, Adaptive Sensory Technology (Code F (Financial Support)); Pradeep Y. Ramulu, None; Jan-Patrick Stellmann, None; Michael Dorr, Adaptive Sensory Technology (Code I (Personal Financial Interest)), Adaptive Sensory Technology (Code I (Personal Financial Interest)), Adaptive Sensory Technology (Code P (Patent))

Purpose:The contrast sensitivity function (CSF) is compromised in many visual neuropathologies. An expert panel proposed acuity and contrast sensitivity as endpoints for public health surveillance of visual impairment[1]. Such endpoints should exhibit the range to measure the population and the precision to track individuals.The purpose of this study was to evaluate contrast sensitivity in normal or impaired vision, including patients with glaucoma, multiple sclerosis (MS), and retinitis pigmentosa (RP). Comparing the population variability of an endpoint with its test-retest variability will help determine its potential for health surveillance.

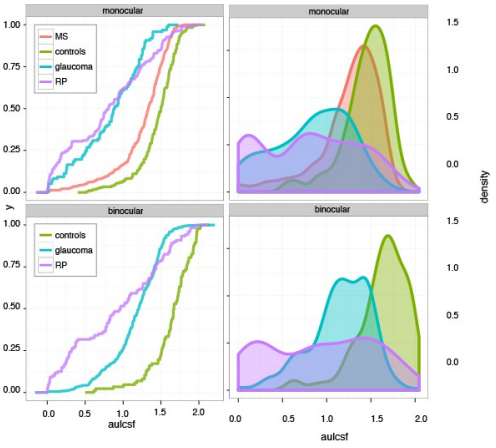
Methods:We collected 1510 CSFs (954 monoc, 556 binoc; 469 MS, 446 glaucoma, 327 RP, and 268 controls) using the qCSF. We computed the Area under the Log CSF (AULCSF) between 1.5 and 18 cpd and CSF acuity, the high-frequency cutoff where sensitivity=0.0. The qCSF can generate credible interval (CI) estimates within single tests, which are closely related to variability across multiple tests [2].

Results:The empirical cumulative distributions for AULCSF are presented in Fig. 1. Both control and patient cohorts exhibit a wide range of vision. Monocular AULCSF values range from .5 to 2.0 for control, 1.25 to 1.75 for MS, and 0.0 to 2.0 decimal log units for RP and glaucoma . There is overlap between the upper limits of the impaired samples and the normal sample. There is little overlap at the lower limits of the controls: no control subjects exhibit AULCSFs below .5. The reliability estimates provided by the credible intervals were only slightly smaller (i.e. tests more precise) for controls (median CI width mono/binocular .10/.11) than patients (glaucoma, .13/.1; RP, .13/.14; MS, .14). This suggests that the underlying assumptions of the qCSF are valid for normal and impaired vision [2].

Conclusions:Our data show that qCSF can assess a broad range of vision, without the floor/ceiling effects of other tests[3]. To distinguish variability in the population and endpoint variability, we demonstrate that credible intervals are small compared to population variability, and comparable to test-retest variabilities in other studies. Further studies will examine the potential for tracking other vision loss, and likewise examine progression and remediation of vision loss over time.
[1] Lee et al (2012) *Am J of Ophthal* 154,6: S3-S7.
[2] Hou et al (2015) *JOV,* 15:2.
[3] Pesudovs et al (2004) *BJO*, 88:11-16.

Layman Abstract (optional): Provide a 50-200 word description of your work that non-scientists can understand.

Describe the big picture and the implications of your findings, not the study itself and the associated details.:



Characterizing the Signal Gain and Internal Noise Profile of Spatial Vision with qCSF

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Posterboard #: B0102

Abstract Number: 203 - B0102

Author Block: *Fang Hou[1] , Luis A. Lesmes[2] , Chang-Bing Huang[3] , Zhong-Lin Lu[1]*
[1] Psychology, The Ohio State University, Columbus, Ohio, United States; [2] Adaptive Sensory Technology, LLC., Boston, Massachusetts, United States; [3] Institute of Psychology, Chinese Academy of Sciences, Beijing, China

Disclosure Block:Fang Hou, None; Luis A. Lesmes, Adaptive Sensory Technology, LLC (Code I (Personal Financial Interest)), Adaptive Sensory Technology, LLC (Code E (Employment)), Adaptive Sensory Technology, LLC (Code P (Patent)); Chang-Bing Huang, None; Zhong-Lin Lu, Adaptive Sensory Technology, LLC (Code I (Personal Financial Interest)), Adaptive Sensory Technology, LLC (Code P (Patent))

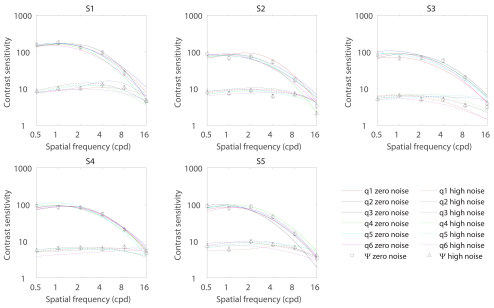
Purpose:Previously, we derived the signal gain and internal noise profiles in spatial vision as functions of spatial frequency through modeling the contrast sensitivity functions (CSF) measured in a range of external noise levels with the method of constant stimuli using a multi-channel perceptual template model (mPTM) (Chen et al., 2014; Hou, Lu, & Huang, 2014). Here, we extended and validated the qCSF method (Lesmes, et al., 2010) originally developed in zero external noise to measure CSF in multiple external noise conditions. The mPTM was used to extract the signal gain and internal noise profiles of spatial vision.

Methods:The CSFs of five normal observers in zero and high external noise conditions were measured in a 4AFC sinewave grating orientation identification task with the qCSF procedure and Ψ method (Kontsevich & Tyler, 1999). External noise was generated by filtering high contrast Gaussian white noise with a one-octave-wide raised cosine filter centered at the test grating spatial frequency. The mPTM, with both signal gain and internal noise profiles described by log parabola functions, was fit to the data.

Results:We found that (1) Consistent with previous studies, the CSFs in the high external noise condition were virtually flat; (2) The CSFs obtained with the qCSF and Ψ methods were highly correlated in both external noise conditions (r = 0.95 ± 0.03); (3) The standard deviation of the CSFs obtained with 100 qCSF trials was 0.06 ± 0.01 and 0.07 ± 0.003 decimal log unit in the zero and high external noise conditions, respectively, with no significant difference between the two ($p > 0.55$). (3) The bias of the CSFs obtained with 100 qCSF trials was 0 ± 0.017 and 0.006 ± 0.041 decimal log unit in the two external noise conditions, with no significant difference ($p > 0.75$). (4) The mPTM accounted for 96.3 ± 2.0% of the variance in the CSF data. The estimated signal gain profile was relatively flat. The magnitude of internal noise elevated with increasing spatial frequency.

Conclusions:The qCSF method can be extended to provide efficient, precise, and accurate measures of CSF in different external noise conditions. The CSFs obtained with 200 qCSF trials in zero and high external noise conditions can be used to reliably estimate the signal gain and internal noise profiles of spatial vision.

Layman Abstract (optional): Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated details.:



The CSFs in zero and high external noise conditions measured by the qCSF and Ψ methods.

Home-Based Self-Assessment of the Contrast Sensitivity Function in Age-Related Macular Degeneration

View Session Detail | Print Abstract

Posterboard #: B0131

Abstract Number: 632 - B0131

Author Block: *Peter Bex[1,2] , Michael Dorr[2,3] , Kameran Lashkari[4] , Luis A. Lesmes[2] , Zhong-Lin Lu[5,2] , Emily K. Wiecek[6]*
[1] Northeastern University, Boston, Massachusetts, United States; [2] Adaptive Sensory Technology, Boston, Massachusetts, United States; [3] Technische Universität München, Munich, Germany; [4] Harvard Medical School, Boston, Massachusetts, United States; [5] Ohio State University, Columbus, Ohio, United States; [6] New England College of Optometry, Boston, Massachusetts, United States

Disclosure Block:Peter Bex, Adaptive Sensory Technology (Code F (Financial Support)), Adaptive Sensory Technology (Code I (Personal Financial Interest)), Adaptive Sensory Technology (Code C (Consultant)), Adaptive Sensory Technology (Code P (Patent)); Michael Dorr, Adaptive Sensory Technology (Code I (Personal Financial Interest)), Adaptive Sensory Technology (Code P (Patent)); Kameran Lashkari, None; Luis A. Lesmes, Adaptive Sensory Technology (Code F (Financial Support)), Adaptive Sensory Technology (Code I (Personal Financial Interest)), Adaptive Sensory Technology (Code E (Employment)), Adaptive Sensory Technology (Code P (Patent)); Zhong-Lin Lu, Adaptive Sensory Technology (Code I (Personal Financial Interest)), Adaptive Sensory Technology (Code C (Consultant)), Adaptive Sensory Technology (Code P (Patent)); Emily K. Wiecek, None

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

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

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

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

Layman Abstract (optional): Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated details.:

Repeatability of contrast testing and the comparison of contrast sensitivity between normal and glaucomatous eyes

View Session Detail | Print Abstract

Posterboard #: B0116

Abstract Number: 617 - B0116

Author Block: *Simrat K. Sodhi[2] , Saghar Bagheri[2] , Yulia Wolfson[2] , Pradeep Y. Ramulu[2] , Pujan Dave[2] , Luis A. Lesmes[1] , Emma McDonnell[2] , Rupert W. Strauss[2] , David S. Friedman[2] , Hendrik P. Scholl[2]*
[1] Adaptive Sensory Technology, Watertown, Massachusetts, United States; [2] Wilmer Eye Institute, Johns Hopkins University, Baltimore, Maryland, United States

Disclosure Block:Simrat K. Sodhi, None; Saghar Bagheri, None; Yulia Wolfson, None; Pradeep Y. Ramulu, None; Pujan Dave, None; Luis A. Lesmes, Adaptive Sensory Technology (Code I (Personal Financial Interest)), Adaptive Sensory Technology (Code E (Employment)), US7938538/WO2013170091 (Code P (Patent)); Emma McDonnell, None; Rupert W. Strauss, None; David S. Friedman, None; Hendrik P. Scholl, None

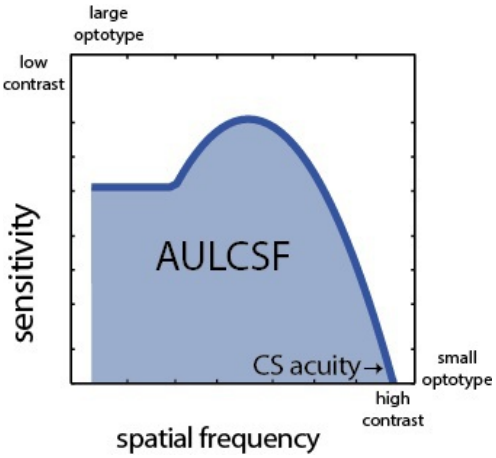
Purpose:The full contrast sensitivity function (CSF) describes different aspects of visual performance including: peak contrast sensitivity (CS) – 1/contrast threshold assessed at medium-to-large optotype sizes – and contrast acuity (CA) – optotype size thresholds assessed at high-contrast. CS testing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

Methods:qCSF data was obtained in 40 eyes (20 normal subjects) and 60 eyes (30 glaucoma subjects) with an average visual field (VF) loss of -9.5 (SD=8.6) dB assessed by Humphrey 24-2. CS data was collected in monocular conditions, with worse-seeing eye retested for glaucoma subjects and both eyes retested for normal subjects. Re-test measurements were obtained to assess repeatability and precision. CS metrics were derived from the qCSF, including area under the log CSF (AULCSF) curve and CA, the high spatial frequency at which sensitivity=0.

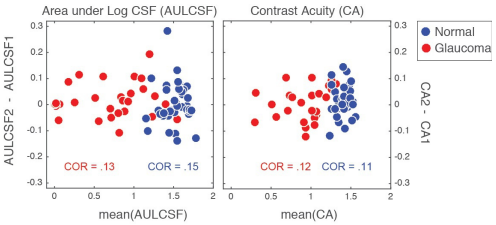
Results:In normal subjects AULCSF (mean=1.58;SD=.15), and CA (mean=1.40;SD=.09) values were consistently higher and less variable than those observed in glaucoma: AULCSF (mean=.88;SD=.47), and CA (mean=1.02; SD=.33). The coefficients of repeatability for AULCSF and CA were .15 and .13 decimal log units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

Conclusions:This study demonstrates that qCSF yields better contrast sensitivity in normal eyes, compared to glaucomatous eyes. Of note, repeatability is comparable in both groups, for both AULCSF and CS metrics. The qCSF exhibits potential as a clinical trial endpoint, as contrast sensitivity has been previously shown to affect visual quality of life.

Layman Abstract (optional): Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated details.:



The CSF, which defines visual performance over stimulus dimensions, summarized by AULCSF and CA.,



Bland-Altman plots presenting AULCSF and CA test-retest scores, and coefficients of repeatability (COR) for normal (blue) and glaucomatous (red) eyes.

Perceptual training significantly improves visual functions in children with amblyopia

View Session Detail | Print Abstract

Posterboard #: B0069

Abstract Number: 3082 - B0069

Author Block: *Ge Chen[1] , Lejin Wang[2] , Fang Hou[3] , Zhong-Lin Lu[3] , Chang-Bing Huang[1]*
[1] Chinese Academy of Sciences, Institute of Psychology, Beijing, Beijing, China; [2] Department of Ophthalmology, Peking University People's Hospital, Beijing, China; [3] Department of Psychology, The Ohio State University, Columbus, Ohio, United States

Disclosure Block:Ge Chen, None; Lejin Wang, None; Fang Hou, Beijing Juehua Medical Technology Co. (Code I (Personal Financial Interest)); Zhong-Lin Lu, Adaptive Sensory Technology (Code P (Patent)), Adaptive Sensory Technology (Code I (Personal Financial Interest)); Chang-Bing Huang, Beijing Juehua Medical Technology Co (Code I (Personal Financial Interest))

Purpose:Although numerous studies have shown that perceptual learning can improve deficient visual functions in adults with amblyopia, the efficacy of perceptual learning in treating children with amblyopia has rarely been investigated. Here, we designed a child-friendly, individualized adaptive vision training (iAVT) based on a visual training procedure originally developed to train adults with amblyopia (Zhou, et al, 2006) to evaluate effects of perceptual learning in children with amblyopia.

Methods:Ninteen amblyopic children (7.78±2.73 yrs) were trained with the iAVT in a filtered letter E orientation identification task near their individual cutoff frequency for 8 sessions, with 300 trials or 30 minutes per session. Contrast sensitivity function (CSF) and visual acuity in both the amblyopic and fellow eyes, and stereo acuity were assessed before and after training. CSF was measured using the qCSF procedure (Lesmes, et al 2010). Each qCSF assessment took less than five minutes.

Results:Training significantly improved visual acuity (2 lines) and contrast sensitivity (53.9%, from 13.01 to 20.02, $p < 0.0001$) in the amblyopic eye, stereo acuity (80.8%, from 606'' to 116.2'', $p < 0.0001$), and contrast sensitivity (24.7%, from 28.4 to 35.4, $p < 0.01$) in the fellow eye. The magnitudes of improvements were correlated with pre-training visual deficits: The worse the pre-training measure was, the greater the improvements. Interestingly, we found no significant correlation among the magnitudes of improvements in visual acuity, contrast sensitivity, and stereo acuity (all $p > 0.39$).

Conclusions:These results demonstrate the merit of perceptual learning in treating children with amblyopia. Consistent with results in adults with amblyopia (Xi, et al 2014), the lack of correlation among improvements in visual acuity, contrast sensitivity, and stereo acuity suggests that structured monocular and binocular treatments are necessary to fully restore deficient visual functions in amblyopia.

Layman Abstract (optional): Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated details.:

Comparison of contrast sensitivity, visual acuity, and the contrast sensitivity function as predictors of gait in glaucoma

View Session Detail | Print Abstract

Posterboard #: A0259

Abstract Number: 1953 - A0259

Author Block: *Angeline M. Nguyen[1] , Aleksandra Mihailovic[1,2] , David S. Friedman[1,2] , Pradeep Y. Ramulu[1,2]*
[1] Johns Hopkins University/ Wilmer Eye Institute, Baltimore, Maryland, United States; [2] Dana Center for Preventive Ophthalmology, Baltimore, Maryland, United States

Disclosure Block:Angeline M. Nguyen, None; Aleksandra Mihailovic, None; David S. Friedman, None; Pradeep Y. Ramulu, None

Purpose:To investigate whether the contrast sensitivity function (CSF), a measure combining visual acuity (VA) and contrast sensitivity (CS), is better at predicting gait parameters than CS or VA alone.

Methods:211 patients with varying degrees of glaucoma damage underwent assessment of CSF using the quick CSF method (Adaptive Sensory Technology), CS using the MARS chart, and VA using the ETDRS chart. qCSF, CS, and VA data were converted to area under log CSF (AULCSF), logCS, and logMAR, respectively. Gait measurements were collected as the average of 4 normal walking trials using the GAITRite Electronic Walkway system (CIR System Inc.). R^2 values of linear regression models were used to determine the extent to which vision measures captured variability in the gait parameter of interest, while controlling for age, sex, race, comorbidities, and polypharmacy.

Results:AULCSF was significantly associated ($p<0.05$) with 5 gait measures (step count, stride length, step length, base of support, and step length difference between feet), with R^2 values ranging from 5%-29%. By comparison, logCS was associated with only 3 gait measures (step count, base of support, and step length difference), while logMAR VA was associated 9 gait measures (those mentioned for AULCSF plus swing time, step time, single support time, and cadence). Of the 3 gait measures demonstrating a significant association with both AULCSF and logCS, R^2 values were all similar (within a range of 1%). For the 5 gait parameters demonstrating a significant association for both AULCSF and logMAR VA (step count, stride length, step length, base of support, and step length difference), model R^2 values was more than 1% higher when AULCSF was the visual predictor for base of support, while R^2 values were within 0.8% for the remaining models.

Conclusions:CSF, CS, and VA all demonstrate an impact of glaucoma on gait, though different gait parameters show inconsistent associations when different measures of vision are employed. More work is required to understand the specific visual features most likely to account for functional impairments in eye disease.

Layman Abstract (optional): Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated details.:

Performance in alternative tests of vision across the spectrum of glaucoma severity.

View Session Detail | Print Abstract

Posterboard #: A0277

Abstract Number: 1971 - A0277

Author Block: *Stephanie Lin[1] , Aleksandra Mihailovic[2] , Sheila K. West[2] , Chris A. Johnson[3] , David S. Friedman[2] , Pradeep Y. Ramulu[2]*

[1] Johns Hopkins University School of Medicine, Baltimore, Maryland, United States; [2] Ophthalmology, Johns Hopkins University/Wilmer Eye Institute, Baltimore, Maryland, United States; [3] Ophthalmology, University of Iowa, Iowa City, Iowa, United States

Disclosure Block:Stephanie Lin, None; Aleksandra Mihailovic, None; Sheila K. West, None; Chris A. Johnson, None; David S. Friedman, None; Pradeep Y. Ramulu, None

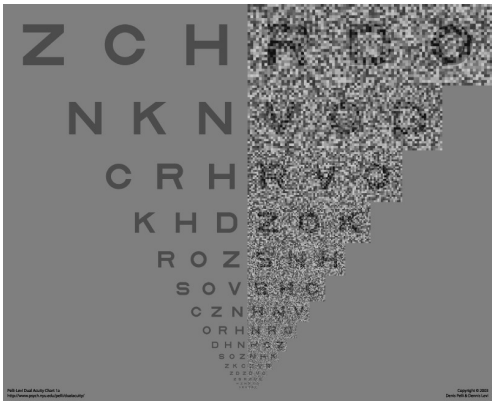
Purpose:Vision in glaucoma is most often tested using visual fields (VFs), visual acuity (VA), or contrast sensitivity (CS), though people with glaucoma may also experience other visual difficulties related to functional loss. Here, we determine how 3 alternative visual metrics vary with glaucoma severity (defined by VFs and the contrast sensitivity function [CSF], which integrates VA and CS results).

Methods:We analyzed data from 183 people age 57 and older with glaucoma or suspected glaucoma. Integrated VF (IVF) sensitivity was calculated from right and left eye 24-2 VFs. The qCSF test was used to measure area under the log CSF (AULCSF). Color vision and distance stereo acuity were evaluated with the HRR plates and Distance Randot Stereotest, respectively. Vision in noise, a measure of acuity tested on pixelated noise, was assessed with the Pelli Levi Dual Acuity Chart. Separate multivariate regression models evaluated associations between either IVF sensitivity or AULCSF and vision in noise, color vision, and stereo acuity, adjusting for age, gender, race, comorbidities, and medications.

Results:Subjects had a mean age of 70.6 (SD=7.6), IVF sensitivity of 26.1dB (IQR=25.1–29.7dB; normal value [NV]=33dB), and AULCSF of 1.2 (IQR=1.04–1.43; NV=1.6). Mean number of noisy letters read was 15.2 (IQR=13–19; NV not described) and mean color symbols seen 17.2 (IQR=18–20; NV=20). Most subjects (77%) had no detectable distance stereo acuity, while 6%, 8%, and 8% had 400, 200, and 60-100 seconds of arc, respectively. Each 5dB decrement in IVF sensitivity was associated with a 65% lower odds of having a higher level of stereo acuity ($p<0.003$), 2.2 fewer noisy letters read ($p<0.001$), and 2.9 fewer color symbols seen ($p<0.001$). Each 0.1 decrement in AULCSF was associated with a 40% lower odds of having a higher level of stereo acuity ($p<0.001$), 1.1 fewer noisy letters read ($p<0.001$), and 0.82 fewer color symbols seen ($p<0.001$). Correlations between IVF sensitivity and vision in noise, color vision, and stereo acuity were 0.54, 0.65, and 0.25, respectively.

Conclusions:Glaucoma influences a variety of visual metrics not typically assessed, including vision in noise, color vision, and stereo acuity. Given the moderate correlations between these and traditional vision metics, further work is required to determine what better reflects functional outcomes.

Layman Abstract (optional): Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated details.:



Pelli Levi Dual Acuity Chart for vision in noise.