A- A+

Accuracy and Precision of the ETDRS Chart, E-ETDRS and Bayesian qVA Method

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Posterboard#: A0405

Abstract Number: 5908 - A0405

AuthorBlock: *Yukai Zhao[1], Luis Andres Lesmes[2], Michael Dorr[3], Peter Bex[4], Zhong-Lin Lu[1]*
[1]Psychology, the Ohio State University, Columbus, Ohio, United States; [2]Adaptive Sensory Technology, Inc, San Diego, California, United States; [3]Technical University of Munich, Munich, Germany; [4]Psychology, Northeastern Unversity, Boston, Massachusetts, United States;

DisclosureBlock: Yukai Zhao, None; Luis Andres Lesmes, Adaptive Sensory Technology, Inc Code I (Personal Financial Interest), Adaptive Sensory Technology, Inc Code E (Employment), Adaptive Sensory Technology, Inc Code P (Patent), Michael Dorr, Adaptive Sensory Technology, Inc Code I (Personal Financial Interest), Adaptive Sensory Technology, Inc Code P (Patent), Peter Bex, Adaptive Sensory Technology, Inc Code I (Personal Financial Interest), Adaptive Sensory Technology, Inc Code P (Patent), Zhong-Lin Lu, Adaptive Sensory Technology, Inc Code I (Personal Financial Interest), Adaptive Sensory Technology, Inc Code P (Patent)

Purpose
Visual acuity (VA) remains a fundamental measure of visual function. The accuracy and precision of VA assessment are extremely important for its use in disease management, therapeutic development, and occupation qualification. Although the ETDRS chart (Ferris III, et al., 1982) with different termination rules and E-ETDRS (Beck et al., 2003) provide the standard VA assessment in clinical trials, different termination rules may yield different VA scores for the same observer (Carkeet, 2001). Recently, Lesmes (2018) introduced a Bayesian adaptive qVA test that estimates the threshold and range of the VA psychometric function (PF) via higher sampling resolution of optotype size and a rich model of row-based PFs (Figure 1). In this study, we use Monte Carlo simulations to evaluate the accuracy and precision of VA assessment using ETDRS with 6 termination rules in current practice, E-ETDRS, and qVA.

Methods
Observers with three different “true” VA thresholds (-0.3, 0.25, and 1 logMAR) and range (0.15, 0.3 and 0.6 logMAR) were simulated. The row-based PFs in qVA were used to simulate observer performance. The six termination rules were: reading the whole chart, or stopping at the line with at least 1, 2, 3, 4, or 5 mistakes. Each qVA run consisted of 45 trials with a row of 3 optotypes in each trial. Each observer was assessed 1000 times by each method.

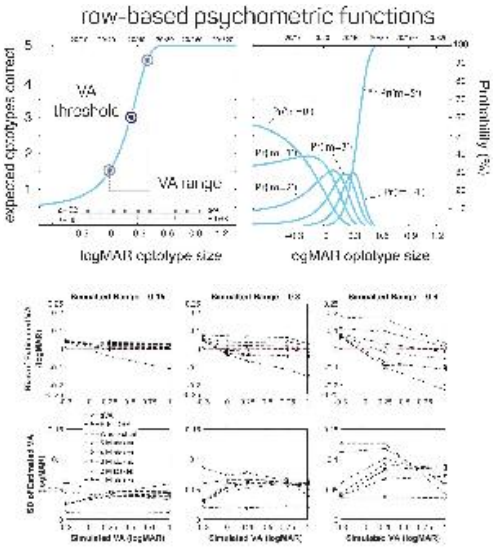
Results
The qVA generated the most accurate (bias: -0.004 to 0.004 logMAR) and precise (SD: 0.010 to 0.037 logMAR) assessment of VA thresholds, across observers (Figure 2). The ETDRS chart with different termination rules yielded VA scores with biases between -0.228 and 0.173 logMAR and SDs between 0.025 and 0.126 logMAR. Among the 6 termination rules, the ETDRS with the 3-mistake termination rule yielded the smallest bias (-0.018 to 0.079 logMAR), and the ETDRS with the whole-chart termination rule yielded the smallest SD (0.026 to 0.071 logMAR). The bias (0.096 to 0.057 logMAR) and SD (0.025 to 0.090 logMAR) of the E-ETDRS were similar to

those of the ETDRS with the 5-mistake termination rule.

Conclusions

The ETDRS with the 6 termination rules and E-ETDRS do not converge to the true acuity of the simulated observers. The qVA provides unbiased and most precise VA assessment.

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.



A- A+

Active Learning of Contrast Sensitivity Function to Assess Visual Outcomes in Age-related macular degeneration

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Posterboard#: A0219

Abstract Number: 1205 - A0219

AuthorBlock: *Ying Cui[1,2], Rebecca Silverman[1,3], Megan A. Kasetty[1,3], June Cho[4], Luis Andres Lesmes[5], Ines Lains[1], Raviv Katz[1], Demetrios Vavvas[1], Deeba Husain[1], Joan W. Miller[1], John B. Miller[1]*
[1]Retina Service, Department of Ophthalmology, Massachusetts Eye and Ear, Harvard Medical School, Boston, Massachusetts, United States; [2]Department of Ophthalmology, Guangdong Eye Institute, Guangdong General Hospital, Guangdong Academy of Medical Sciences, Guangzhou, Guangdong, China; [3]Tufts Medical School, Boston, Massachusetts, United States; [4]Northeastern University, Boston, Massachusetts, United States; [5]Adaptive Sensory Technology, San Diego, California, United States;

DisclosureBlock: Ying Cui, None; Rebecca Silverman, None; Megan A. Kasetty, None; June Cho, None; Luis Andres Lesmes, Adaptive Sensory Technology Code P (Patent), Adaptive Sensory Technology Code I (Personal Financial Interest), Adaptive Sensory Technology Code E (Employment), Ines Lains, None; Raviv Katz, None; Demetrios Vavvas, None; Deeba Husain, Genentech Code C (Consultant), Alcon/Novartis Code C (Consultant), Joan W. Miller, Bausch + Lomb Code C (Consultant), Genentech/Roche Code C (Consultant), Genentech/Roche Code R (Recipient), KalVista Pharmaceuticals Code C (Consultant), ONL Therapeutics Code C (Consultant), ONL Therapeutics Code P (Patent), ONL Therapeutics Code R (Recipient), Valeant Pharmaceuticals/Mass. Eye and Ear Code P (Patent), Valeant Pharmaceuticals/Mass. Eye and Ear Code R (Recipient), Lowy Medical Research Institute Code F (Financial Support), John B. Miller, Allegan Code C (Consultant), Alcon Code C (Consultant), Genentech/Roche Code C (Consultant), Heidelberg Code R (Recipient), Zeiss Code R (Recipient), Optovue Code R (Recipient)

Purpose
To evaluate the application of active learning to measure the contrast sensitivity function in age-related macular degeneration (AMD).

Methods
Prospective, observational study performed at Mass Eye and Ear. We included eyes with dry AMD and wet AMD and excluded other visually significant diseases or previous ocular surgeries (except anti-VEGF intravitreal injection and cataract surgery). Eyes were tested with quick contrast sensitivity function (qCSF) using the Manifold platform (Adaptive Sensory Technologies, San Diego, CA) and spectral domain optical coherence tomography (Heidelberg). The main outcome measure was the area under log contrast sensitivity function (AULCSF). Secondary outcomes were contrast sensitivity thresholds at six spatial frequencies (1, 1.5, 3, 6, 12, 18CPD), contrast acuity (CA) and best corrected visual acuity (BCVA, LogMAR). All measures were compared to previously collected data in control eyes. After adjusting for sex and age, general linear models were used to compare the means of continuous variables.

Results
We included 40 eyes from 30 AMD patients and 30 eyes from 30 controls, mean aged 71.4±8.4 and 65.1±5.9

years old respectively. Sixteen eyes presented dry AMD, while 24 had wet AMD. Among the last, 13 eyes had fluid under the fovea. AMD eyes differed significantly from control eyes in BCVA (LogMAR, 0.13 VS. 0.01, P=0.001), mean AULCSF (0.75 ± 0.34 VS. 1.17 ± 0.26, P<0.001) and CA (1.04 ± 0.23 VS. 1.22 ± 0.13, P=0.023), after adjusting for sex and age. Eyes with dry AMD had a statistically significant reduction in AULCSF (P<0.05) despite no difference in visual acuity when compared to controls (P>0.05). There was also a non-significant reduction in AULCSF and CA in eyes with wet AMD compared to dry AMD (P>0.05). However, when looking at intermediate spatial frequencies, eyes with wet AMD had significantly reduced contrast thresholds compared to dry AMD at 1.5CPD, 3CPD and 6CPD (P<0.05).We found no statistically significant differences (*P*>0.05) in BCVA, mean AULCSF and CA between wet AMD patients with and without fluid under fovea.

Conclusions
An active learning algorithm reveals patterns of contrast sensitivity loss in eyes with AMD, which can be correlated with structural changes in AMD. These contrast sensitivity outcomes exhibit potential as endpoints in clinical trials for the treatment of AMD.

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.

A- A+

Active Learning of the Contrast Sensitivity Function as a New Clinical Endpoint for Retina Vein Occlusion

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Posterboard#: B0110

Abstract Number: 2579 - B0110

AuthorBlock: *Raviv Katz[1], Rebecca Silverman[2], Megan Kasetty[1,2], June Cho[3], Luis Andres Lesmes[4], Leo A. Kim[1], John B. Miller[1]*

[1]Retina Service, Massachusetts Eye and Ear Infirmary, Department of Ophtahlmology, Harvard Medical School, Massachusetts, United States; [2]Tufts Medical School, Boston, Massachusetts, United States; [3]Northeastern University, Boston, Massachusetts, United States; [4]Adaptive Sensory Technology INC., San Diego, California, United States;

DisclosureBlock: Raviv Katz, None; Rebecca Silverman, None; Megan Kasetty, None; June Cho, None; Luis Andres Lesmes, Adaptive Sensory Technology INC. Code P (Patent), Adaptive Sensory Technology INC. Code I (Personal Financial Interest), Adaptive Sensory Technology INC. Code E (Employment), Leo A. Kim, None; John B. Miller, Allergan Code C (Consultant), Alcon Code C (Consultant), Genetech Code C (Consultant), Heidelberg Code R (Recipient), Zeiss Code R (Recipient), Optovue Code R (Recipient)

Purpose

Traditional letter visual acuity does not always adequately describe a patient's visual limitations or pathologic changes in a variety of maculopathies. Herein, we evaluate the utility of quantitative contrast sensitivity function (qCSF) testing in patients with retinal vein occlusion (RVO).

Methods

Prospective, observational, IRB-approved study. All patients had a history of RVO in one or both eyes. Exclusion criteria was cataract status >2+ nuclear sclerosis, or visual acuity (VA) <20/200. Patients were tested using the Manifold Platform (Adaptive Sensory Technology, San Diego, CA) and SD-OCT at their regularly scheduled visits. This active learning approach estimates a CSF model using an information-gain strategy, which provides a global functional vision metric via the area under the CSF (AULCSF), in addition to sensitivities at varying spatial frequencies. Contrast sensitivity was compared to previously collected data for 62 eyes from age-matched healthy controls.

Results

21 patients with RVO (21 eyes) were tested with a mean age of 60.0 years ± 12.0. The mean BCVA was logMAR 0.19 ± 0.14 (~20/32) with a mean AULCSF of 0.811 ± 0.288. Compared to the healthy controls, (AULCSF = 1.20) we found a statistically significant reduction in mean AULCSF of eyes with RVO ($p<.0001$). The presence of macular edema significantly reduced contrast sensitivity relative to eyes with RVO but NO macular edema ($p<.04$), but did not reduce acuity ($p>.05$). For a small set of eyes (n=4), the therapeutic effect of a single anti-VEGF injection was measured: Mean AULCSF improved from 0.816 (SD 0.205) to 1.253 (SD 0.4) ($p = 0.027$), while logMAR VA did not show analogous statistically significant improvements ($p = 0.062$).

Conclusions

qCSF testing confirms reduced contrast thresholds in patients with RVO, and demonstrates the potential for

measuring large treatment effects in RVO.

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.

A- A+

Active learning of contrast sensitivity function as a clinical endpoint in cataract disease

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Posterboard#: A0400

Abstract Number: 5903 - A0400

AuthorBlock: *Megan A. Kasetty[1,3], Rebecca Silverman[1,3], Rebecca Zeng[1,4], Zhonghui K. Luo[2], Ryan Vasan[2], Alice Lorch[2], June Cho[5], Luis Andres Lesmes[6], John B. Miller[1]*
[1]Retina, Massachusetts Eye and Ear, Boston, Massachusetts, United States; [2]Comprehensive Ophthalmology and Cataract, Massachusetts Eye and Ear, Boston, Massachusetts, United States; [3]Tufts University School of Medicine, Boston, Massachusetts, United States; [4]Boston University School of Medicine, Boston, Massachusetts, United States; [5]Northeastern University, Boston, Massachusetts, United States; [6]Adaptive Sensory Technology, Inc., San Diego, California, United States;

DisclosureBlock: Megan A. Kasetty, None; Rebecca Silverman, None; Rebecca Zeng, None; Zhonghui K. Luo, None; Ryan Vasan, None; Alice Lorch, None; June Cho, None; Luis Andres Lesmes, Adaptive Sensory Technology, Inc. Code P (Patent), Adaptive Sensory Technology, Inc. Code I (Personal Financial Interest), Adaptive Sensory Technology, Inc. Code E (Employment), John B. Miller, Allergan Code C (Consultant), Alcon Code C (Consultant), Genetech Code C (Consultant), Heidelberg Code R (Recipient), Zeiss Code R (Recipient), Optovue Code R (Recipient)

Purpose
Traditional letter visual acuity does not adequately describe a patient's visual limitations in cataract disease. There is a need for a patient-centered, functional endpoint that can be tested efficiently in clinic and appropriately reflects patients' subjective vision. We performed a prospective, observational, IRB-approved study to evaluate contrast sensitivity using a quick contrast sensitivity function (CSF) test in eyes with nuclear sclerotic cataract.

Methods
Eyes with cataract status >/= 2+ nuclear sclerosis were included in the study. All patients had subjective visual complaints. Eyes with best-corrected Snellen visual acuity less than 20/30 or presence of additional ocular pathology were excluded from analysis. CSF was tested using the Manifold Platform (Adaptive Sensory Technology, San Diego, CA). This active learning approach estimates CSF using an information-gain strategy. The main outcome measure is a vision metric represented by the area under the CSF curve (AULCSF). Secondary outcome measures included contrast sensitivity thresholds at six spatial frequencies and high contrast acuity. Outcome measures were compared to data from 40 age-matched control eyes. A small subset of eyes that underwent cataract surgery also had qCSF testing done 1-2 weeks postoperatively.

Results
36 eyes with cataract from 27 patients were included in the study. The mean age was 68 years ± 7. Mean visual acuity was 0.098 logMAR±0.06 (~20/25) and mean AULCSF was 0.997±0.21. Compared to age-matched controls (mean AULCSF = 1.164±0.26), we found a statistically significant reduction in CSF in cataract eyes ($p<0.0001$). High contrast acuity did not show a statistically significant reduction ($p=0.121$). In the 8 eyes that

underwent cataract surgery, mean AULCSF increased from 1.05±0.23 to 1.33±0.14 (p=0.003). Following surgery, AULCSF increased an average of 32% with less than 1 line improvement (4.7 letters) in best-corrected visual acuity.

Conclusions
This active learning platform confirms a visually significant decrease in CSF in cataract eyes despite visual acuity better than or equal to 20/30. We observed a significant increase in CSF and subjective marked improvement in visual acuity with seemingly small improvement in traditional Snellen testing following cataract surgery. This demonstrates the potential for measuring treatment effects in eyes with cataract and other eye diseases using this platform.

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.

A- A+

Improved estimation of subtle, but noticeable changes in functional vision using new tests of visual acuity and contrast sensitivity

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Posterboard#: B0062

Abstract Number: 3630 - B0062

AuthorBlock: *Emma Flor[1], Andrea M. Janoff[1], Luis Andres Lesmes[4], Manonmani Murugappan[2], Maryn JaNet Barnes[1], Ava K. Bittner[1,3]*

[1]College of Optometry, Nova Southeastern University , Davie, Florida, United States; [2]College of Osteopathic Medicine, Nova Southeastern University, Davie, Florida, United States; [3]Ophthalmology, University of California, Los Angeles, Los Angeles, California, United States; [4]Adaptive Sensory Technology, California, United States;

DisclosureBlock: Emma Flor, Adaptive Sensory Technology Code F (Financial Support), Adaptive Sensory Technology Code R (Recipient), Andrea M. Janoff, Adaptive Sensory Technology Code F (Financial Support), Luis Andres Lesmes, Adaptive Sensory Technology Code I (Personal Financial Interest), Adaptive Sensory Technology Code E (Employment), Adaptive Sensory Technology Code P (Patent), Manonmani Murugappan, Adaptive Sensory Technology Code F (Financial Support), Adaptive Sensory Technology Code R (Recipient), Maryn JaNet Barnes, Adaptive Sensory Technology Code F (Financial Support), Ava K. Bittner, Adaptive Sensory Technology Code F (Financial Support)

Purpose

True changes in central visual function that are small in magnitude but subjectively appreciated may not necessarily be documented as being statistically significant due to potential measurement-related issues with existing chart-based tests of visual acuity (VA) and contrast sensitivity (CS). We determined optical intervention-related changes in VA and CS for existing tests compared to two novel tests.

Methods

The ETDRS trans-illuminated VA chart, Pelli-Robson CS, and active learning adaptive tests of VA (i.e., quantitative VA) and CS function (i.e., quantitative CSF) were repeated at two visits in 50 eyes of 25 normally-sighted, pre-presbyopic adults without ocular disease. Subjects were randomized and masked to perform these tests at 3-4m while wearing daily disposable Acuvue or Alcon contact lenses with distance-only and multifocal correction.

Results

All except two subjects (92%) were accurately able to identify which contact lens was the multifocal, based on subjective visual disturbances. The qVA test measured a significantly greater VA loss with the multifocal on average when compared to the ETDRS chart (0.18±0.10 vs . 0.14±0.12 log units; p=0.03). The qCSF test measured a slightly greater CS loss at 3cpd with the multifocal on average when compared to the Pelli-Robson chart (-0.13±0.15 vs. -0.09±0.11 log units; p=0.12). Hypothesis testing for detecting VA loss of >7.5 letters with the multifocal with the qVA test was marginally significant (p=0.028; one-sided), but not significant for the ETDRS chart (p>0.50). For detecting CS degradations of >0.20 logCS with the multifocal lens, the measured changes were significant at 3, 6, and 12 cpd with the qCSF (p<0.025; one-sided), but not significant for Pelli-Robson (p>0.50).

Conclusions
The definition of clinically meaningful changes in vision is constrained by what is clinically measurable, thus it is important to build better tools to detect subtle changes in visual function that are noted by patients. Our findings support that enhanced test design can reveal significant visual changes that have perceptual correlates.

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.

A- A+

Mapping contrast sensitivity of visual field with Bayesian adaptive qVFM method

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Posterboard#: A0104

Abstract Number: 4377 - A0104

AuthorBlock: *Pengjing Xu[2], Luis Andres Lesmes[1], Deyue Yu[3], Zhong-Lin Lu[2]*
[1]Adaptive Sensory Technology, California, United States; [2]Psychology, The Ohio State University, Columbus, Ohio, United States; [3]College of Optometry, The Ohio State University, COLUMBUS, Ohio, United States;

DisclosureBlock: Pengjing Xu, The Ohio State University Code P (Patent), Luis Andres Lesmes, Adaptive Sensory Technology Code I (Personal Financial Interest), Adaptive Sensory Technology Code E (Employment), Adaptive Sensory Technology Code P (Patent), Deyue Yu, The Ohio State University Code P (Patent), Zhong-Lin Lu, Adaptive Sensory Technology Code I (Personal Financial Interest), The Ohio State University Code P (Patent)

Purpose
Current clinical evaluation,which focuses on central vision,could improve characterization of residual vision with peripheral testing of visual acuity,contrast sensitivity,color vision,crowding,and reading speed.Assessing more than light sensitivity,a comprehensive visual field map(VFM) of functional vision would be valuable for detecting and managing eye diseases.

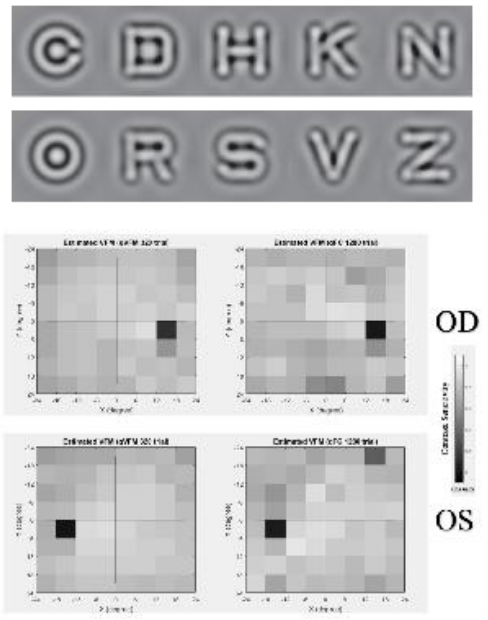
Methods
We previously developed a Bayesian adaptive qVFM method that combines a global approach for preliminary assessment of the VFM's shape,and a local approach for assessment at individual retinal locations.The method was validated in measuring the light sensitivity map.In this study,we extended qVFM to measure contrast sensitivity across visual field.In both simulations and psychophysics,we sampled 64 visual field locations(48x48 deg) and compared qVFM with a procedure testing locations independently(qFC;Lesmes et al.,2015).Subjects were identified a single optotype (size: 2.5x2.5deg),one of 10 Sloan alternatives,filtered with a raised cosine filter and octave bandwidth.On each trial,contrast and location was adaptively selected.Three eyes were simulated to compare the accuracy and precision of VFMs measured with 1280 trials of each method.In addition,data were collected from eight eyes(4 OS,4 OD) of four normal observers.

Results
For simulations,the average bias of qVFM and qFC contrast threshold estimates(in log10 units) were 0.021 and 0.072 after 320 trials,0.0079 and 0.0080 after 1280 trials.The average standard deviation(SD) of qVFM and qFC estimates were 0.053 and 0.089 after 320 trials, 0.031 and 0.049 after 1280 trials.The estimated within-run variability(68.2% HWCIs) were comparable to the estimated cross-run variability(SD).For psychophysics,the average HWCI of qVFM and qFC estimates across the visual field decreased from 0.28 on the first trial to 0.083 and 0.15 after 160,to 0.061 and 0.092 after 320 trials.The root mean squared error(RMSE) of thresholds estimated with qVFM and qFC started at 0.21, decreased to 0.12 after 160 and to 0.10 after 320 trials.

Conclusions
The qVFM provides an accurate,precise,efficient mapping of contrast sensitivity across the entire visual

field.The method could find potential clinical applications in monitoring vision loss,evaluating therapeutic interventions,and developing effective rehabilitation for low 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.
This study presents an accurate, precise, and efficient method to map contrast sensitivity across the entire visual field. The method can be extended to map other visual functions, with potential clinical signals for monitoring vision loss, evaluating therapeutic interventions, and developing effective rehabilitation for low vision.



A- A+

The repeatability of visual changes measured with tests of visual acuity and contrast sensitivity

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Posterboard#: A0401

Abstract Number: 5904 - A0401

AuthorBlock: *Manonmani Murugappan[2], Andrea M. Janoff[1], Luis Andres Lesmes[4], Emma Flor[1], Maryn JaNet Barnes[1], Ava K. Bittner[1,3]*

[1]College of Optometry , Nova Southeastern University, Tampa, Florida, United States; [2]College of Osteopathic Medicine, Nova Southeastern University, Fort Lauderdale, Florida, United States; [3]Ophthalmology, University of California, Los Angeles, Los Angeles, California, United States; [4]Adaptive Sensory Technology, California, United States;

DisclosureBlock: Manonmani Murugappan, Adaptive Sensory Technology Code F (Financial Support), Adaptive Sensory Technology Code R (Recipient), Andrea M. Janoff, Adaptive Sensory Technology Code F (Financial Support), Luis Andres Lesmes, Adaptive Sensory Technology Code I (Personal Financial Interest), Adaptive Sensory Technology Code E (Employment), Adaptive Sensory Technology Code P (Patent), Emma Flor, Adaptive Sensory Technology Code F (Financial Support), Adaptive Sensory Technology Code R (Recipient), Maryn JaNet Barnes, Adaptive Sensory Technology Code F (Financial Support), Ava K. Bittner, Adaptive Sensory Technology Code F (Financial Support)

Purpose

The recent applications of active learning algorithms to testing visual acuity (VA) and contrast sensitivity function (CSF) – quantitative VA (qVA) and quantitative CSF (qCSF) – reflect an attempt to develop tools with higher stimulus resolution, better test precision, and improved detection of vision changes related to intervention or ocular disease progression. We compared the test-retest repeatability of the qVA and qCSF tests to the standard ETDRS VA and Pelli-Robson CS charts.

Methods

At two visits about one week apart, the same test battery was repeated, involving two measures of distance VA (ETDRS trans-illuminated chart and qVA) and two tests of distance CS (Pelli-Robson and qCSF) in a total of 50 eyes in 25 normally-sighted, pre-presbyopic adults without ocular disease. Subjects performed all tests with daily disposable Acuvue or Alcon contact lenses with distance-only and multifocal correction to introduce some visual degradation. Between-visit repeatability was determined with 95% coefficients of repeatability (CR).

Results

For the two visual conditions, 95% CRs for distance-only and multifocal correction were 0.18 and 0.18 log units for ETDRS VA, 0.12 and 0.16 log units for qVA, 0.20 and 0.21 logCS for Pelli-Robson, and 0.23-0.25 and 0.24-0.29 logCS for qCSF area under the log curve (AUC) or at 1.5, 3 and 6 cpd, respectively. The magnitude of vision loss with the multifocal lens was not significantly different between the two visits for each of the four tests (all $p>0.05$). Cohen's d effect size reflects both the magnitude of visual change and test repeatability, which was 1.16 and 1.61 for ETDRS VA and qVA, respectively, 0.77 for Pelli-Robson CS, 1.20 for qCSF AUC, and 0.31, 0.75, and 1.11 for qCSF at 1.5, 3 and 6 cpd, respectively.

Conclusions
As part of central visual function test validation and selection, it is important to determine and consider both the test repeatability and magnitude of visual changes of interest that are documented with each test. Improving Cohen's d effect size for detected visual changes has the potential to reduce sample sizes in 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.

A- A+

Unbiased Threshold Estimates in Bayesian Adaptive qCSF and qFC with Mismatched Psychometric Function Slopes

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Abstract Number: 3908

AuthorBlock: *Zhong-Lin Lu[1], Yukai Zhao[1], Luis Andres Lesmes[2], Michael Dorr[3], Peter Bex[4]*
[1]Psychology, The Ohio State University, Columbus, Ohio, United States; [2]Adaptive Sensory Technology, Inc, San Diego, California, United States; [3]Technical University of Munich, Munich, Germany; [4]Northeastern University, Boston, Massachusetts, United States;

DisclosureBlock: Zhong-Lin Lu, Adaptive Sensory Technology, Inc Code I (Personal Financial Interest), Adaptive Sensory Technology, Inc Code P (Patent), Yukai Zhao, None; Luis Andres Lesmes, Adaptive Sensory Technology, Inc Code I (Personal Financial Interest), Adaptive Sensory Technology, Inc Code E (Employment), Adaptive Sensory Technology, Inc Code P (Patent), Michael Dorr, Adaptive Sensory Technology, Inc Code I (Personal Financial Interest), Adaptive Sensory Technology, Inc Code P (Patent), Peter Bex, Adaptive Sensory Technology, Inc Code I (Personal Financial Interest), Adaptive Sensory Technology, Inc Code P (Patent)

Purpose
To improve data quality in basic and clinical applications, Bayesian methods have been developed to adaptively assess thresholds on single [1,2] or multiple psychometric functions (e.g., the contrast sensitivity function [3,4]). To simplify these procedures – reduce model parameters and increase estimation efficiency - the slope of the psychometric function can be fixed [3,4]. However, a model mismatch occurs when the assumed slope differs from observer's true slope. What is the impact of this mismatch on the accuracy, precision, and efficiency of adaptive estimation? In this study, we used Monte Carlo simulations to show that, for methods with fixed slopes, the qFC [2] in m-alternative forced choice tasks (m=2, 4, 8, and 10) and qCSF [3,4]: (1) there exists a d' performance level at which the estimated threshold is unbiased, and (2) precision and efficiency increase with the observer's true slope.

Methods
For qFC, seven simulated observers, one with matched (3.05, 3.45, 3.90, and 4.05 for m=2, 4, 8, and 10, respectively) and six with mismatched slopes (0.5, 1, 2, 5, 6, 8) were simulated in each m-alternative task. The thresholds (d'=0.5 to 3.5) of each simulated observer were estimated with the qFC (100 trials) method 1000 times. For qCSF, six observers, one with matched (4.05), four with a single mis-matched (1, 2, 6, and 8, respectively) across all spatial frequencies (SFs), and one with two mis-matched slopes (8 when SF < 4 cpd; 1 when SF ≥4 cpd), were simulated. The CSFs (d'=0.5 to 3.5) of each simulated observer were estimated with the qCSF (200 trials) method 500 times.

Results
The results are shown in Table 1. We found that the value of d' where bias = 0 depended on the number of alternatives in forced choice tasks. Precision and the 68.2% half-width confidence intervals (HWCI) of the estimated thresholds increased with slope. Efficiency increased with slope and with the number of alternatives in forced choice tasks.

Conclusions

Even under mismatched conditions, Bayesian adaptive methods with a fixed slope can generate unbiased threshold estimates in certain d' performance levels. The results provide the theoretical basis to use psychometric functions with fixed slopes in parametric Bayesian adaptive procedures.
REFS: [1] Kontsevich & Tyler, 1996; [2] Lesmes et al., 2015; [3] Lesmes et al., 2010; [4] Hou et al., 2015.

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.

		Slope=2		Slope=8		# trials for SD = 0.1 log10	
mAFC	d' where bias=0	SD (log10)	HWCI (log10)	SD (log10)	HWCI (log10)	Slope=2	Slope=8
2	1.47	0.054	0.041	0.025	0.037	46	24
4	1.69	0.043	0.028	0.018	0.026	27	17
8	1.92	0.038	0.023	0.015	0.021	23	10
10	2.02	0.038	0.022	0.015	0.021	23	10
qCSF	1.96	0.041	0.019	0.016	0.015	45	20

A- A+

Assessing peripheral visual function in myopia – a qCSF study

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Posterboard#: A0081

Abstract Number: 4365 - A0081

AuthorBlock: *Zhipeng Chen[1], Zhong-Lin Lu[2], Fang Hou[3], Siyuan Deng[1], Shenglan Zhang[1], Jinrong Li[1]*
[1]Zhongshan Ophthalmic Center, Sun Yat-sen University, Guangzhou, Guangdong, China; [2]Department of Psychology, The Ohio State University,, Columbus, Ohio, United States; [3]Wenzhou Medical University, Wenzhou, Zhejiang, China;

DisclosureBlock: Zhipeng Chen, None; Zhong-Lin Lu, Adaptive Sensory Technology Code I (Personal Financial Interest), Adaptive Sensory Technology Code P (Patent), Fang Hou, None; Siyuan Deng, None; Shenglan Zhang, None; Jinrong Li, None;

Purpose
The peripheral retinal structure is very important in the pathogenesis and management of myopia. However, the quantitative relationship between peripheral visual function and myopia remains unknown. This study evaluated contrast sensitivity function in peripheral vision in myopia and emmetropia with the qCSF method.

Methods
The study recruited 19 myopia subjects (23.42±4.0 years) and 12 normal subjects (22.92±2.9 years). The average spherical and cylinder corrections were -2.95±3.26D and -0.03±0.74D in myopia group, and -0.34±0.52D and -0.30±0.42D in normal group. The BCVA was 0.00±0.00 logMAR in both groups. All subjects performed the qCSF test in foveal vision and fifteen peripheral locations (superior, inferior, temporal and nasal quadrants at 6^0, 12^0, 18^0 and 24^0 eccentricities, excluding the physiological scotoma at 18^0) and optical quality assessment with the double-pass Optical Quality Analysis System II, OQAS. The myopes wore soft contact lens with best corrected visual acuity (BCVA). To summary metrics, the cutoff spatial frequency (cut-off SF) and the area under log CSF (AULCSF), and contrast thresholds at 19 spatial frequencies (equally spaced in log units) at each of the 16 test locations were derived from qCSF test results.

Results
Results from the OQAS assessment found that there was no significant optical quality difference between two groups, including MTF cutoff, OV100%, OV20%, and OV9% and OSI ($p>0.10$). There was also no significant difference between two groups in any of the CSF metrics in foveal vision ($p>0.10$). Further analysis showed that myopes had significantly increased AULCSF in the superior ($p=0.026$), inferior ($p=0.024$) and nasal ($p=0.022$) quadrants at 12^0. Across the fifteen peripheral locations, there was no significant cut-off SF difference between two groups ($p>0.10$). In addition, contrast sensitivity in the myopia group was greater than that of normal group in the inferior quadrant at 6^0 ($p<0.05$), and the superior, inferior and nasal quadrants at 12^0 ($p<0.05$), but not at any of the other test locations.

Conclusions
Our findings showed that, with best optical correction, the myopic visual system exhibited normal CSF in foveal vision but enhanced CSF in certain peripheral locations. We speculate that these results may be attributed to compensatory improvements of peripheral vision from its extensive use during near visual activities in the

emmetropization process of myopic visual system.

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.

A- A+

The Visual Quality and its Related Life Quality of Pterygium

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Posterboard#: A0360

Abstract Number: 4469 - A0360

AuthorBlock: *Jin Yuan[1], zhong jing[1], Zhong-Lin Lu[3], Fang Hou[4], Michael Dorr[5], Zhipeng Chen[2], Shenglan Zhang[2], Jinrong Li[2]*
[1]cornea, ZhongShan Opthalmic Center, Guagnzhou, China; [2]zhongshan ophthalmic center, , China; [3]Ohio State University, Ohio, United States; [4]School of Ophthalmology & Optometry and Eye Hospital, Wenzhou Medical University, , China; [5]Technical University of Munich, , Germany;

DisclosureBlock: Jin Yuan, None; zhong jing, None; Zhong-Lin Lu, Adaptive Sensory Technology Code I (Personal Financial Interest) , Adaptive Sensory Technology Code P (Patent) , Fang Hou, None; Michael Dorr, Adaptive Sensory Technology Code I (Personal Financial Interest) , Adaptive Sensory Technology Code P (Patent) , Zhipeng Chen, None; Shenglan Zhang, None; Jinrong Li, None;

Purpose
To assess the visual quality including the optical quality and contrast sensitivity function(CSF) of pterygium patients, as well as the prognosis postoperatively

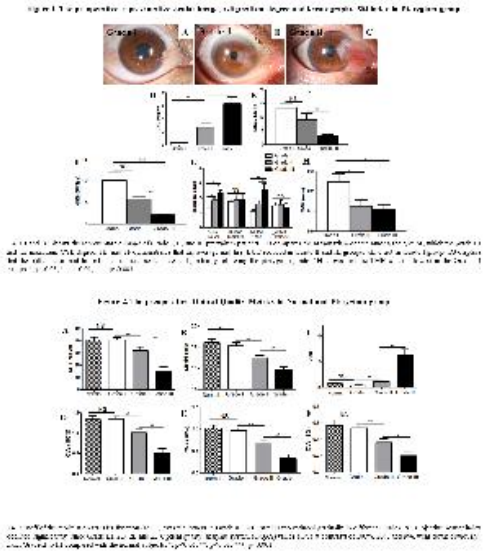
Methods
31 pterygium patients at different levels (14 cases of Grade I, 13 Grade II and 8 Grade III; mean age: 47.8±9.2 yrs) were included in this study. All patients underwent a routine ophthalmic examination, quick CSF tests under full optical correction, the Optical Quality Analysis System (OQAS) test, the oculus keratography 5M (K5) and filled out the VFQ-25 visual quality questionnaire preoperatively. After surgery, the visual quality was followed at the 1st, 3rd and 6th month

Results
The degree of astigmatism increased gradually with the severity of the pterygium, which were -0.30±0.07DS in Grade I, -2.68±0.59 D (*P*=0.0021) in Grade II and -6.25±1.06(*P* =0.0059) in Grade III; accordingly, the mean NEI VFQ-25 scores decreased from 73.0±2.0 in Grade I to 64.6±2.0(*P* =0.07) in Grade II and 55.0±2.9 (*P*= 0.03) in Grade III. In the K5 test, the bulbar nasal and limbal nasal redness scale increased gradually following the pterygium grade while not the bulbar nasal and limbal nasal, and the nasal side's redness scale correlated with the degree of astigmatism positively (r = -0.467, P = 0.0071). In the optical quality, the MTF cutoff was the lowest in the Grade III compared with Grade II and I (14.74±3.94 VS 31.99±2.81 VS 40.41±1.89 ; *P*<0.001). Both the MTFcutoff and the SR correlated positively with the astigmatism degree (*r* = -3.34, *P* = 0.0025; *r* = -0.40, *P* = 0.0008). In CSF, the cutoff SF was obviously damaged in Grade II (14.79±1.28 cpd, *P* = 0.048) and III (12.79±1.28 cpd, *P* = 0.026) patients compared with the normal's (17.21±1.24 cpd), while not of the Grade I (12.79±1.28 cpd, *P* = 0.577). The AULCSF of Grade II (1.08 ± 0.29, *P* = 0.026) and III group (0.83 ± 0.32) was significantly lower than that of the normal group (1.21 ± 0.05 , *P* = 0.023). Postoperatively, the degree of astigmatism, the NEI VFQ-25, and the contrast sensitivity showed obvious improvement since the 1st month.

Conclusions
The optical quality and contrast sensitivity were damaged in Grade II and III pterygium patients, which

correlated with the severity of pterygium and its induced astigmatism. Patients following surgery exhibited obvious improvement of visual quality since the 1st month, which provided a good reference clinically.

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.



A- A+

Perceptual learning along the “weaker” principal meridian improves contrast sensitivity function and visual acuity in patients with astigmatism

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Posterboard#: A0397

Abstract Number: 5900 - A0397

AuthorBlock: *Li Gu[1], Jinrong Li[1], zhong jing[1], Zhipeng Chen[1], Shenglan Zhang[1], Zhong-Lin Lu[2], Jin Yuan[1]*
[1]Zhongshan Ophthalmic Center, Guangzhou, Guangdong, China; [2]The Ohio State University, Ohio, United States;

DisclosureBlock: Li Gu, None; Jinrong Li, None; zhong jing, None; Zhipeng Chen, None; Shenglan Zhang, None; Zhong-Lin Lu, Adaptive Sensory Technology Code I (Personal Financial Interest), Adaptive Sensory Technology Code P (Patent), Jin Yuan, None;

Purpose
Astigmatism before visual development results in abnormal visual development due to principal meridional variations in visual processing. The current study aims to 1) assess the contrast sensitivity function (CSF) in two principal meridians, and 2) evaluate the effects of perceptual learning on CSF and visual acuity in patients with astigmatism.

Methods
Ten subjects with with-the-rule astigmatism (mean age = 13.90 ± 1.73 years) participated in baseline assessments, which consisted of visual acuity and CSFs measured with both vertical and horizontal sinewave gratings. They were then trained in a luminance grating orientation identification task (±5°) around either the vertical or horizontal direction at their individual cutoff spatial frequency, whichever had relatively poorer CSF. Post-training assessments were the same as the baseline.

horizontal meridian was lower than that on the vertical meridian (two-tailed paired t-test, t_9=1.94, p=0.084), demonstrating differential effects of astigmatism on visual processing in different meridians. In addition, training in the weaker vertical meridian near each individual's cut-off SF led to significant improvements in contrast sensitivity at the trained SF measured with vertical sinewave gratings (4.50 dB or 67.96%; two-tailed paired t-test, t_9=2.81, p=0.020). No significant improvement was found in contrast sensitivity at the trained SF measured with horizontal sinewave gratings. Moreover, the training improved visual acuity of the trained eye by 3.70 dB (or 53.17%).

Conclusions
Patients with astigmatism showed meridional variations on CSF along their principal meridians at baseline. Perceptual training in the "weaker" principal meridian improved VA due to the improved CSF in the weaker meridian and reduced difference between the two meridians. These findings demonstrate effects of astigmatism on visual processing and provide empirical evidence for perceptual learning as a potential treatment for astigmatism.

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.

A- A+

Natural History of Visual Function Impairment in Patients Post-treatment with Pan-retinal Photocoagulation for Proliferative Diabetic Retinopathy

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Posterboard#: A0184

Abstract Number: 6556 - A0184

AuthorBlock: *Xing Chen[1], Amro Omari[1], Min Hwang[1], Thomas W. Gardner[1]*
[1]Department of Ophthalmology and Visual Sciences, Kellogg Eye Center University of Michigan, Ann Arbor, Michigan, United States;

DisclosureBlock: Xing Chen, None; Amro Omari, None; Min Hwang, None; Thomas W. Gardner, Novo Nordisk Code C (Consultant) , Zebra Biologics Code F (Financial Support)

Purpose
Proliferative diabetic retinopathy (PDR) is characterized by formation of new, fragile blood vessels that can bleed and obscure vision. It is commonly treated with pan-retinal photocoagulation (PRP) to reduce the risk of severe vision loss. However, PRP often impairs peripheral and central visual field function. The purpose of this study is to investigate the natural course of visual function in patients who had regressed PDR after PRP.

Methods
We recalled 22 diabetic participants who had previously undergone PRP (1-32 years ago) and 11 age-matched controls for repeat evaluation 4-5 years after baseline evaluation. The PRP had been performed, on average, 18.4 (range: 1-32) years previously. Tests included Pelli Robson contrast sensitivity, quick Contrast Sensitivity Function, Minnesota reading test, Frequency Doubling Technology 24-2 program, Humphrey Field Analyzer 10-2 and 60-4 program, photostress, and dark adaptation, along with the National Eye Institute Visual Function Questionnaire (NEI VFQ)-25 and the Low Luminance Questionnaire (LLQ). Data analysis was performed using SPSS. Independent and dependent *t*-tests were used to compared between groups and between two time points.

Results
At the follow-up visit, the diabetic group performed worse than the control group in all visual function tests and questionnaires, showing impairment in central and peripheral vision, and lower quality of life. However, the diabetic group who had received PRP showed no significant decline in any major vision and quality of life parameters when adjusted for the effect of aging.

Conclusions
This natural history study demonstrates that, even many years after PRP treatment, PDR patients can have stable visual function with mild deterioration over time, possibly associated with aging. This is the first longitudinal study that assessed visual function in patients years after laser treatment for PDR. These findings may help to design future clinical trials to improve vision in persons who have received PRP for PDR.

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.

A- A+

Impact of mesopic test conditions on visual function measures in retinitis pigmentosa versus normals

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AuthorBlock: *Ava K. Bittner*[2,1]
[1]Optometry, Nova Southeastern University, College of Optometry, Ft. Lauderdale, Florida, United States; [2]Stein Eye Institute, UCLA, Los Angeles, California, United States;

DisclosureBlock: Ava K. Bittner, Adaptive Sensory Technology Code F (Financial Support)

Presentation Description
During ETDRS visual acuity (VA), Pelli-Robson contrast sensitivity (CS), and quick contrast sensitivity function (qCSF) testing (i.e., area under the log CSF: AULCSF, CSF acuity, and CS at 1.5 cpd or 6 cpd) in both retinitis pigmentosa (RP) and normally-sighted adults, measures of mesopic visual function were obtained while subjects wore U23 NoIR 4% transmission filters, which were compared to measures at the same visit in typical photopic test conditions. Results from two visits within ~2-4 weeks were used to determine between-visit test-retest variability as 95% coefficients of repeatability. When compared to the normally-sighted, subjects with RP had statistically significantly greater reductions in CS (both Pelli-Robson and qCSF) in mesopic versus photopic conditions. When comparing the difference in mesopic and photopic CS in normally-sighted adults, there was less mesopic CS loss at lower spatial frequencies (i.e., Pelli-Robson at 1 meter and qCSF at 1.5 cpd) and greater mesopic CS loss at middle and higher spatial frequencies measured with the qCSF test, while those with RP tended to have more mesopic CS loss than normals for CSF acuity at the highest spatial frequency and CS at low spatial frequencies. Across both RP and normally-sighted subjects, those with a greater loss of photopic (typical) visual function had a statistically significantly greater amount of mesopic loss with the same test (VA, Pelli-Robson CS, or qCSF). In RP, the reduction in visual function in the mesopic condition compared to photopic (typical) testing was not statistically significantly related to whether they currently had remaining rod function as determined by the AdaptDx or whether they had ever seen stars as a child. Between-visit test-retest differences were not statistically significant different when comparing photopic versus mesopic test conditions for VA, qCSF or Pelli-Robson CS testing in either RP or normally-sighted, and 95% coefficients of repeatability were similar between subject groups. The Pelli-Robson CS test did not detect a significant loss of mesopic contrast sensitivity relative to age. Normally-sighted older adults in their 70s-80s had significantly greater loss of qCSF AULCSF in the mesopic versus photopic condition compared to younger adults, which is likely mediated by natural loss of rod sensitivity with aging.

A- A+

Can vision functions predict Para Alpine skiing performance?

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Posterboard#: A0003

Abstract Number: 1045 - A0003

AuthorBlock: *Kristine Dalton[1], Amritha Stalin[1], Marieke Creese[2]*
[1]School of Optometry & Vision Science, University Of Waterloo, Waterloo, Ontario, Canada; [2]International Paralympic Committee, , Germany;

DisclosureBlock: Kristine Dalton, None; Amritha Stalin, None; Marieke Creese, None;

Purpose
Para Alpine skiing requires athletes to move quickly through an environment that rapidly changes during and between runs, and is a highly challenging sport for skiers with vision impairments. The current International Paralympic Committee (IPC) classification criteria for athletes with vision impairment competing in Para sport are based on static visual acuity and visual field radius of the better eye, but do not account for the dynamic vision demands of sports like skiing. To help develop an evidence based, sport-specific classification system for Para Alpine skiing, a prospective observational study was conducted to examine the relationships of vision functions and skiing performance. Static and dynamic VA, contrast sensitivity, and glare sensitivity were hypothesized to be predictive of skiing performance.

Methods
Elite Para Alpine skiers (n=15) were recruited at the 2017 Para Alpine Skiing World Championships. Static visual acuity (SVA), light sensitivity, glare sensitivity, glare recovery, dynamic visual acuity (DVA), contrast sensitivity, translational and radial motion perception, and visual field were assessed binocularly in all skiers. Skiing performance was assessed with a modified IPC Alpine Skiing (IPCAS) points system based on athlete's raw times. Performance on the vision function tests was compared with skiing performance in each discipline (downhill (DH), super G (SG), giant slalom (GS), slalom (SL)) using Kendall's correlations and bootstrapped linear multiple regressions ($p<0.05$ considered significant).

Results
DVA and DH performance were significantly correlated ($\rho= 0.593$, $p=0.04$; better DVA associated with better performance), however, in the regression models no variables were significantly predictive of DH performance after bootstrapping. SVA was found to be a significant predictor for GS [$(F(3,11)=24.71$, $p<0.001)$, with an $R^2$of 0.87], SG [$(F(3,9)=17.34$, $p=0.002)$, with an $R^2$of 0.85], and SL [$(F(3,11)=11.8$, $p=0.002)$, with an $R^2$of 0.80] performance in the regression models. Better SVA was also correlated with better skiing performance in SG and GS disciplines ($\rho>0.50$, $p<0.01$).

Conclusions
Consistent with our hypotheses, SVA was predictive of GS, SG, and SL performance, which require more technical skill and less speed than DH. Dynamic visual acuity was not predictive of skiing performances, but it was significantly associated with DH performance.

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.

A- A+

Contrast Sensitivity Function (CSF) of Anisometropia with Spectacle Lens and Soft Contact Lens.

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Posterboard#: A0396

Abstract Number: 5899 - A0396

AuthorBlock: *Ming Li[1], Lele Cui[1], Lei Zhang[1], Weihe Zhou[1], Fang Hou[1]*
[1]Ophthalmology, Eye Hospital of Wenzhou Medical University, Wenzhou, China;

DisclosureBlock: Ming Li, None; Lele Cui, None; Lei Zhang, None; Weihe Zhou, None; Fang Hou, None;

Purpose
The aim of this study was to evaluate contrast sensitivity function (CSF) of anisometropia with spectacle lens and soft contact lens.

Methods
4 anisometropia and 4 control subjects were included in this pilot study. All the subjects were asked to wear the spectacle lens and soft contact lens respectively during the CSF test. The Bayesian adaptive quick contrast sensitivity function (qCSF) method with 10 Digits was used for CSF assessment. Dominant eye (DE), non-dominant eye (NDE) and binocular (BE) qCSF were conducted respectively. The area under the log CSF curve, peak gain, peak spatial frequency, bandwidth at half-height and low-frequency truncation level were used to estimate the entire CSF curve.

Results
All the qCSF parameters were obtain for all the subjects with spectacle lens and soft contact lens. The areas under the log CSF curves of binocular qCSF are larger than those of dominant eye or non-dominant eye in both anisometropia and control groups with spectacle lens or soft contact lens ($p < 0.05$). For the low-frequency truncation level, either dominant or non-dominant eye is smaller than binocular qCSF in both anisometropia and control groups only with soft contact lens ($p < 0.05$). No significant differences were evident for other qCSF parameters among anisometropia and control groups with spectacle lens and soft contact lens.

Conclusions
Binocular vision will be helpful for CSF of the anisometropia whether with spectacle lens or soft contact lens. No significant CSF differences were found for anisometropia with spectacle lens and soft contact lens.

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.