10:00 AM 2 hours | Room 228
P-07 | **Papers: Reading, Eye Movement & Low Vision**
Moderators: Eli Peli, MSc, OD, FAAO, Susana Chung, OD, PhD, FAAO

10:00 AM. Keynote: **EYE MOVEMENTS AND IMPAIRED VISION A NEW-OLD FRONTIER**
Eli Peli, MSc, OD, FAAO

10:30 AM. **DEPENDENCE OF CROWDED ACUITY ON CONTRAST IN CENTRAL AND PERIPHERAL VISION** (120584)
Jeremy M. Chin, BA, OD, Daniel Coates, MS, Susana TL Chung, OD, PhD, FAAO, University of California Berkeley

RESULTS: As expected, acuity was better at the fovea than in the periphery, and better for higher- than lower-contrast stimuli. In general, acuity improved with contrast up to 30% letter contrast at the fovea and 10% at 10&deg ecc, beyond which acuity was independent of contrast. This dependence of acuity on contrast was similar for single and flanked conditions. When plotted as a function of letter spacing, acuity improved with spacing until the critical spacing beyond which acuity was independent of spacing. The critical spacing (in deg of visual angle) increased as stimulus contrast decreased at the fovea, but the dependence of critical spacing on contrast was weaker in the periphery.
PURPOSE: Crowding, the difficulty in identifying a letter embedded in other letters, could affect acuity measured on a chart with multiple letters. Little is known about how acuity measured in the presence of other letters changes with contrast, especially in the periphery where crowding is more substantial. In this study, we evaluated how letter acuity is affected by crowding and contrast in the normal fovea and periphery.
METHODS: Visual acuity was measured using 4-orientation Tumbling Es that varied in size according to a 3 down-1 up staircase tracking threshold to 79% correct. In separate blocks of trials, the target E was presented alone or flanked by 4 other Es of random orientations at a center-to-center letter spacing ranging from 1.2x to 5x the letter size. Stimuli were presented for 150 ms on a white background at a luminance contrast ranging from 2.5% to 99%. Three young adults with normal vision identified the orientation of the target E at the fovea and 10&deg in the inferior visual field.
CONCLUSIONS: The dependence of acuity on contrast and letter spacing should be taken into account for designs of acuity charts that include low-contrast letters; when acuity or contrast sensitivity is measured using charts with multiple letters; or when acuity is measured for people with severe contrast deficits, regardless of whether they have intact central vision.
ADDITIONAL COMMENTS: Supported by NIH grant R01-EY012810

10:45 AM. **FIXATION PRECISION IN READING ESTIMATED WITH AN ADDED NOISE PARADIGM** (120494)

Emily E. Horn, Alyssa Baevich, OD, Scott Stevenson, PhD, University of Houston College of Optometry

RESULTS: Although subject RR's varied greatly, a trend existed that as horizontal position error increased RR was not significantly affected until a critical amount of error. Beyond this critical position error RR increased exponentially. A similar trend existed for critical vertical position error. The amount of position error tolerated in the vertical direction (mean 9.5 arc minutes +/- 1.5 SEM) was significantly less across all subjects than the position error tolerated in the horizontal direction (45.4 +/- 7.4, ($p<0.05$ by paired t-test).

PURPOSE: Reading eye movement models have been formulated to predict the "visual span" size of fixations during reading, but it is more difficult to determine the precision of reading saccades. Saccadic precision cannot be easily measured since the target is not precisely known. The goal of this study was to investigate the amount of inherent error of saccades or "internal tolerance" during reading, using an added noise paradigm.

METHODS: 9 subjects were asked to read aloud sentences from the MNRead database while their eye movements were measured & recorded using a SRI generation V dual-Purkinje infrared eye tracking system. A horizontal saccade contingent added noise paradigm was used so that the sentence position shifted a certain amount during every horizontal saccade the subject made while reading. Sentence display position was jittered in steps that varied from 0 to 192 min of arc in the horizontal direction during one session and in the vertical direction during a later session (8 of the 9 subjects returned for vertical noise component). The reading rate (RR) was plotted against the SD of the errors added with each saccade. A two line least squares fit was used to determine the amount of noise that just begins to affect RR.

CONCLUSIONS: Vertical position error tolerance was significantly less for all subjects than horizontal position error tolerance. While it is important for saccades to be relatively accurate vertically on the line of text during oral reading, the distance the saccade travels horizontally seems to be much less critical.

11:00 AM. **THE EFFECT OF FONT BOLDNESS ON READING SPEED IN CENTRAL AND PERIPHERAL VISION** (120037)

Jasmine Junge, Jean-Baptiste Bernard, PhD, Girish Kumar, OD, PhD, Susana TL Chung, OD, PhD, FAAO, University of California Berkeley

RESULTS: As expected, reading was faster at the fovea and for the larger print size. At the fovea, reading speed was invariant for the middle 5 levels of boldness, but dropped by 23% for the least and the most bold text. At 10&deg eccentricity, reading speed was virtually the same for all boldness <1, but showed a poorer tolerance to bolder text, dropping by 21% for 1.93x boldness and 50% for the most bold (2.93x) text. These results could not be explained by the changes in print size or visibility of text associated with changes in font boldness.

PURPOSE: People with central vision loss often prefer bold-type print over normal print for reading. Does reading speed really benefit from bold-type print? Here, we examined

the reliance of reading speed on font boldness, and whether this reliance differs between the normal central and peripheral vision.
METHODS: Six observers with normal vision (aged 17-24) read aloud short sentences presented on a computer monitor, one word at a time, using rapid serial visual presentation (RSVP). Text was rendered in Courier at 7 levels of font boldness, defined as the stroke-width normalized to that of the standard Courier font: 0.21, 0.5, 0.71, 1, 1.5, 1.93 and 2.93x the standard. Testings were conducted at the fovea and 10&deg in the inferior visual field (an Eyelink II was used to monitor fixation). At each testing eccentricity, we first determined the critical print size (CPS) for each observer using text of standard boldness. We then measured reading speeds (based on RSVP exposure durations yielding 80% of words read correctly) for text rendered at different boldness and at 0.8x and 1.4x CPS. Control experiments were performed to ensure that our results were not due to changes in print size or visibility of text when fonts became less or more bold.
CONCLUSIONS: Our results suggest that contrary to the popular belief, reading speed does not benefit from bold text in the normal fovea and periphery. Excessive increase in font boldness may even impair reading speed especially in the periphery.
ADDITIONAL COMMENTS: Supported by NIH grants T35-EY007139 and R01-EY012810.

11:15 AM. **CONTRIBUTIONS OF REBOUND NYSTAGMUS (RN) TO THE HORIZONTAL GAZE NYSTAGMUS (HGN) TEST** (120080)
Alyssa Baevich, OD, Emily E. Horn, BS, Scott Stevenson, PhD, University of Houston College of Optometry

RESULTS: 4 of 12 subjects showed baseline EPN, and 11 of 12 exhibited detectable EPN when switching from right to left gaze after 20 seconds. Overall, amplitude, frequency, and drift rate were significantly different ($p<0.05$ by t-test) for 20 seconds right gaze followed by 20 seconds left gaze. For each of the three durations of gaze, a statistical difference also existed ($p<0.05$) between left and right gaze. While no statistical difference was found between the three durations and the amplitude of EPN, a general upward trend was observed.
PURPOSE: To investigate the potentially confounding effect of RN on the widely used HGN sobriety test, in which law enforcement officers direct a suspect to follow a target 45 degrees to the right and left. This study examines how differing durations of prolonged lateral gaze such as from faulty test administration can affect endpoint nystagmus (EPN) in the opposite direction of gaze.
METHODS: 12 subjects fixated on and followed a target 45 degrees to their right and held for 20 seconds, 45 degrees to their left and held for 20 seconds, and then returned to primary gaze. 5 subjects returned to repeat the procedure three more times, fixating in right gaze for durations of 5, 10, and 15 seconds. A monitoring apparatus consisting of a camera, IR LED, and visual target all mounted on a rotating arm was used to direct fixation and to record left eye movements. A customized Matlab program tracked the pupil and glint from the light source and extracted eye movements, which were further analyzed to detect saccades of 1 degree visual angle or larger.
CONCLUSIONS: Results suggest RN contributes to baseline EPN, and prolonging

lateral gaze for even a short period of time can induce RN. Should these sober subjects have been pulled over and tested, the majority would not have passed the HGN component of the sobriety test. Law enforcement officers should thus take care to not further bias the HGN test by prolonging suspect lateral gaze.
ADDITIONAL COMMENTS: This project was supported in part by training grant T35 EY07088 from the National Eye Institute.

11:30 AM. **PERIPHERAL PRISM GLASSES FOR HEMIANOPIA IMPROVE OBSTACLE DETECTION DURING VIRTUAL WALKING** (120979)
Kevin Houston, OD, FAAO, Jeffrey Churchill, BA, Gang Luo, Russell L. Woods, BOptom, PhD, FAAO, Eli Peli, MSc, OD, FAAO, Schepens Eye Research Institute

RESULTS: Blind side detection failures were significantly higher without correction (median 59%; IQR 16%-69%) than with p-prisms (median 0%; IQR 0-8; p=0.012). Only 2 subjects failed to show improvement with p-prisms. Collision judgments in the prism expanded vision were generally poor with the majority of subjects calling any detection a collision.
PURPOSE: Although peripheral prisms (p-prisms) for hemianopia can be shown to expand the blind hemifield 20-25 degrees in conventional perimetry, obstacle detection through the prisms during mobility has never been directly measured. Virtual reality provides safe environments in which scenarios can be created to evaluate the impact of visual aids on mobility-related tasks. We measured obstacle detection and collision judgments of patients with and without p-prisms walking in a virtual reality shopping mall.
METHODS: Nine patients with quadranopia or hemianopia were seated in front of a rear projection screen presenting a moving scene which simulated walking down a shopping mall corridor. P-prisms were placed on the patient for the testing session without any demonstration or training. In each trial, a life-size human figure appeared randomly at a range of offsets from the walking direction. Each testing session was composed of 88 trials, 44 on each side. Patients verbalized if they would have collided with the figure.
CONCLUSIONS: P-prisms improved obstacle detection on a complex moving background, as would be required for collision avoidance. Although blindside detection improved on immediate application of the prisms, collision judgments were incorrect. We have developed a touch screen program to train adaptation to the prismatic shift and have begun a study to see if this improves collision judgments.

11:45 AM. **EVALUATING OCULOMOTOR RESPONSE TO PRISM IN MACULAR DEGENERATION PATIENTS WITH SCANNING LASER OPHTHALMOSCOPE** (120639)
Matt S. Valdes, OD, Stanley Woo, OD, MS, FAAO, Joshua D. Pratt, University of Houston College of Optometry, George C. Woo, The Hong Kong Polytechnic University School of Optometry

RESULTS: Re-fixation to displaced target for the AMD group was within 3 pixels or 11.66 arc minutes (mean [SD], 2.9, [3.92] and mean, [SD], 2.53, [4.18]). The control group re-fixated more accurately (mean [SD], 0.33, [1.14] and mean, [SD], 0.88, [2.50]),

but was not statistically different from the AMD group (t_{5y}=1.33, p=0.256 and t_{5y}=0.38, p=0.723). Time to re-fixate demonstrated that the control group (mean [SD], 0.98 sec, [0.19 sec]) was quicker than that of the AMD group (mean [SD], 2.83 sec, [1.63 sec]) and was statistically significant (t=5.03, p=0.004). One patient did not re-fixate. His data was excluded and analyzed individually.
PURPOSE: The purpose of this study is to use a scanning laser ophthalmoscope (SLO) to evaluate the oculomotor response to ophthalmic prism in patients with bilateral central scotomas.
METHODS: Six low vision patients with bilateral central scotomas and six normally sighted patients were recruited. Nidek MP1 microperimetry was performed to confirm an absolute central scotoma and identify the patient?s preferred retinal locus (PRL). A Rodenstock SLO captured real time images of the retina while projecting a target onto the previously identified PRL. A 6-8 prism diopter lens was then introduced, while the patient was instructed to maintain fixation on the target. Retinal landmarks were used to measure the retinal image shift secondary to fixation target shift and subsequent re-fixation with the PRL. Average deviation from displaced fixation target and time (timestamp video) to re-fixate were calculated using ImageJ software.
CONCLUSIONS: For our sample we were able to conclude that with the introduction of prism, patients with bilateral central scotomas will refixate similar to our control group. However, time to re-fixate was significantly slower in the AMD group. Prism relocation resulted in re-fixation in 5/6 subjects. This data suggests that image relocation does not appear to benefit patients with established PRLs.