Purpose: To characterize the conjugate eye movements of patients with Crouzon syndrome.

Methods: Ten children with Crouzon syndrome were studied, five had a pattern strabismus (V-pattern exotropia or A-pattern esotropia); the remaining five had normal eye alignment in primary gaze. We recorded gaze holding and conjugate eye movements in response to stimuli designed to elicit smooth pursuit, saccades, optokinetic nystagmus (OKN), vestibular-ocular reflex (VOR) and vergence using binocular or monocular video-oculography.

Results: Gaze holding was stable in 8 of 10 patients. Two patients using binocular or monocular video-oculography.

Visual field deficits in albinism

Purpose: Albinism is associated with known retinal deficits such as foveal hypoplasia, a midline shift in the line of decussation and optic nerve head abnormalities. Visual field results in albinism to a nystagmus cohort without obvious retinal characteristics dramatically changing in vertical and horizontal planes. This method may by an effective way of objectively measuring changes in null region characteristics brought about by interventions such as surgical and pharmacological treatments.

Commercial Relationships: Vijay Patel, None; Frank A. Proudlock, None; Irene Gottlob, None

Program Number: 2659
Presentation Time: 9:00 AM–9:15 AM

Visual field testing was completed monocularly using a Humphrey Field Analyzer on 61 participants with albinism and 32 with IN. In all participants monocular light spot detection threshold were assessed using automated white on white perimetry with a SITA 24-2 algorithm to compare the detection threshold for up to 24° around the fixation point. We analyzed each quadrant (upper nasal, upper temporal, lower nasal and lower temporal) of the visual field excluding the blind-spot. We also compared central detection thresholds to the layer thicknesses at the fovea and across the parafoveal region in 99 eyes with albinism and 54 eyes with IN assessed using OCT.

Purpose: Head postures associated with infantile nystagmus (IN) often have horizontal, vertical and torsional components. We have developed a novel method to visualise null regions by mapping nystagmus waveforms at horizontal and vertical gaze angles for experimental and clinical use. The aim of the study was to use this method to characterise two dimensional (2D) null regions in IN and assess if they are accessed functionally during tasks of increasing visual demand.

Methods: Horizontal and vertical eye movements (EyeLink 1000) and roll, pitch and yaw head movements (InertiaCube motion tracker) were recorded in 20 participants with IN (10 with albinism, 7 idiopathic, 3 achromats) while performing tasks of increasing visual demand, i.e. eyes closed, fixation (with and without a mental maths task), reading (Radner reading test) and visual acuity (Landolt Cs). The head position during each task was compared to 2D null region maps generated by plotting the nystagmus characteristics (intensity and foveation) when fixing a target (head fixed), mapping out a grid covering a horizontal range from -30° to +30° and vertical range from 15° upwards to 30° downwards (in 7.5° steps). 2D null region maps were compared at two different distances (1.2m and 0.4m).

Results: 2D null region maps were observed in most participants, with nystagmus characteristics dramatically changing in vertical and horizontal planes. Horizontal and vertical head postures were used to access 2D null regions during tasks of higher visual demand with the result that absolute eye angles during head postures were significantly closer to null regions during the visual acuity task compared to the fixation (with and without a mental maths task) and eye closed tasks (p<0.05). A similar pattern was also observed during the reading task, however was only significantly different to the fixation with mental maths task (p<0.05). 2D null regions changed considerably for most participants between the two viewing distances (0.4m and 1.2m).

Conclusions: These findings demonstrate that 2D null region mapping provides a useful way of visualising the null region in IN that is functionally relevant and comprehensively describes the null region in horizontal and vertical planes. This method may by an effective way of objectively measuring changes in null region characteristics brought about by interventions such as surgical and pharmacological treatments.

Commercial Relationships: Vijay Patel, None; Frank A. Proudlock, None; Irene Gottlob, None
**Results:** The detection threshold in albinism was significantly worse compared to the IIN group for all quadrants compared to IIN (p<0.01). Detection thresholds were also significantly worse in the left eye compared to the right (p=0.008) for albinism. In albinism the upper nasal visual field was significantly worse than the upper temporal (p=0.004), lower temporal (p=0.013) and lower nasal (p=0.02) fields. There were no significant differences between the quadrants or eyes in the IIN group. We found significant correlations between central detection threshold and retinal thickness across the parafoveal region (p=0.016), retinal nerve fiber layer (p=0.002 at fovea, p=0.001 across parafovea), inner nuclear layer (p=0.005 at fovea), outer nuclear layer (p=0.001 at fovea, p=0.003 across parafovea), outer segment (p=0.005 at fovea). No significant correlations were found for the IIN group.

**Conclusions:** Light spot detection thresholds provide further insight into the cortical re-organization occurring in albinism. They also demonstrate that upper / lower visual pathway asymmetries as well as nasal / temporal asymmetries exist in albinism. OCT findings indicate that detection thresholds relate to structural abnormalities of the retina showing that there is clinical value in performing visual fields in albinism.

**Commercial Relationships:** Viral Sheth, None; Irene Gottlob, None; Sarim Mohammad, None; Rebecca J. McLean, None; Frank A. Proudlock, None

**Support:** Ulverscroft Foundation

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**Program Number:** 2660  
**Presentation Time:** 9:15 AM–9:30 AM

**Magnetic Resonance Imaging (MRI) of Differential Compartmental Function of Extraocular Muscles (EOMs)**

**During Vertical Fusional Vergence**
Joseph L. Demer1, 2; Robert A. Clark1; 1Ophthalmology, Jules Stein Eye Inst, UCLA, Los Angeles, CA; 2Neurology, UCLA, Los Angeles, CA

**Purpose:** Differential compartmental activation of horizontal rectus EOMs has been suggested as a possible vertical vergence mechanism. We used MRI to evaluate EOM compartmental function during vertical fusional vergence.

**Methods:** Surface coil MRI of the orbits was performed at 312 mm pixel resolution in 2 mm thick quasi-coronal planes in 6 normal young adults who binocularly fused a target affixed to the scanner bore. MRI was repeated for each orbit with and without a 2 PD (1°) base up prism over each eye monocularly. Posterior partial volumes (PPV) were determined as indices of contractility for medial and lateral compartments of vertical rectus EOMs, for superior and inferior compartments of horizontal rectus EOMs, and for medial and lateral compartments of superior oblique (SO).

**Results:** There was no significant PPV change for either compartment of superior rectus in prism viewing or fellow eyes. There was a large and similar PPV increase in both inferior rectus (IR) compartments in the prism viewing orbit, (analyzed as IRI and IRm) and corresponding decrease in the fellow orbit as appropriate to the vertical vergence. There was no PPV change in either medial rectus compartment (analyzed as MRI and MRs) in the prism viewing or fellow eye. However, there was a large and similar PPV increase in the lateral rectus (LR) superior (LRS) compartment in both the prism viewing and fellow orbits (P<0.01), compared with an insignificant change in LR inferior (LRi) compartments. There was a greater PPV reduction in the medial than lateral SO of the prism viewing than fellow orbit, and a greater PPV increase in the lateral than medial SO in the fellow orbit (P<0.05).

**Conclusions:** Differential compartmental contractility of horizontal rectus EOMs does not implement the vertical component of vertical fusional vergence, which is mainly accomplished by the IR without much contribution from SR. While selective bilateral contractility of LRs and bilateral differential contractility of both SO compartments are antagonistic to the vertical component of vertical fusional vergence, these behaviors are appropriate to mediate the torsional component.

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**Results:** Superior LR compartment LRs contracted significantly more than the inferior compartment LRi in prism viewing orbit.

**Commercial Relationships:** Joseph L. Demer, None; Robert A. Clark, None

**Support:** NIH grant EY08313 and Research to Prevent Blindness

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work. Randomized clinical trials support that Office-Based Vergence and Accommodative Therapy with home reinforcement leads to a sustained reduction in patient symptoms. However, the underlying neurophysiological basis for treatment is unknown.

**Methods:** Functional activity and vergence eye movements were quantified from seven binocularly normal controls (BNC) and four CI patients before and after 18 hours of vision therapy. An fMRI conventional block design of sustained fixation versus vergence eye movements stimulated activity in the frontal eye fields (FEF), the posterior parietal cortex (PPC) and the cerebellar vermis (CV). Peak velocity was computed for 4 degree convergence step responses.

**Results:** Comparing the CI patient’s baseline to the after vision therapy data sets with a paired t-test revealed the following: 1) the percent BOLD signal change significantly increased within the CV (p<0.05), FEF (p<0.01) and PPC (p<0.01), 2) the peak velocity from 4° symmetrical vergence step responses increased (p<0.01), and 3) patient symptoms assessed using the CI Symptom Survey (CISS) improved (p<0.05). CI patient measurements after vision therapy were more similar to those observed within BNC. A regression analysis revealed the peak velocity from BNC and CI patients before and after vision therapy was significantly correlated to the percent BOLD signal change within the FEF (r=0.5; p<0.05), PPC (r=0.7; p<0.01); and CV (r=0.6; p<0.01).

**Conclusions:** Results have clinical implications for understanding the behavioral and neurophysiological changes after vision therapy in patients with CI, which may lead to the sustained reduction in symptoms.

**Commercial Relationships:** Tara Alvarez, None; Rajbir Jaswal, None; Suril Gohel, None; Bharat B. Biswal, None

**Support:** NSF MRI CBET1228254

**Program Number:** 2662
**Presentation Time:** 9:45 AM–10:00 AM

**Persistence of oculomotor training effects in mild traumatic brain injury (mTBI)**

Preethi Thiagarajan1, 2, Kenneth J. Ciuffreda2. Retina Foundation of the Southwest, Dallas, TX; 2State College of Optometry, State University of New York, New York, NY.

**Purpose:** Our previous study found considerable positive oculomotor training (OMT) effects in individuals with mTBI and nearwork-related visual symptoms/clinical signs. Here, persistence of the initial post-training improvements in the same individuals were assessed during the 3 and 6 months follow-up period.

**Methods:** Basic clinical measures of oculomotor behavior were assessed in 15 young-adults (age range: 18-40 years) with mTBI before and after OMT using standardized clinical assessment methods. In addition, reading eye movements were objectively recorded using the Visagraph system. Furthermore, nearvision symptoms were assessed using the Convergence Insufficiency Symptom Survey (CISS), and subjective visual attention was tested with the Visual Search and Attention Test (VSAT). Eight out of the original 15 individuals who completed the OMT were reassessed at 3-months and 6-months following the OMT.

**Results:** Thirteen out of the 18 clinical parameters tested were abnormal at baseline. Repeated measures, one-way ANOVA (with missing data compensation) demonstrated the following: 3 parameters showed a significant effect (p<0.05) immediately after OMT; with persistence at 3 and 6 months (p<0.05): near point of convergence (NPC) break, NPC recovery, and positive fusional vergence (PFV) recovery. Four parameters showed a significant effect (p<0.05) at the 3 and 6 month follow-up only: vergence facility, Visagraph reading rate, fixations/100 words, and grade-level efficiency. Two other parameters showed a ‘trend’ (p=0.08) for improvement immediately after OMT: binocular accommodative amplitude and binocular accommodative facility. Thus, 7 parameters showed a persistent and positive, significant OMT effect out of the 13 parameters that were abnormal at baseline.

**Conclusions:** The results demonstrate both short-term and long-term OMT effects. The short-term effects demonstrate presence of robust and rapid visual neuroplasticity, even in a damaged adult brain, whereas the latter suggests a combined neural ‘consolidation’ effect and an oculomotor learning/practice effect with the now improved visual/oculomotor system, following the OMT.

**Commercial Relationships:** Preethi Thiagarajan, None; Kenneth J. Ciuffreda, None

**Support:** DoD W81XWH-10-1-1041, DoD W81XWH-12-1-0420, AOF Ezell Fellowship, COVD, and SUNY Graduate Program

**Program Number:** 2663
**Presentation Time:** 10:00 AM–10:15 AM

**The Infant Aphakia Treatment Study (IATS): Fixational Instabilities Following Extraction of Unilateral Infantile Cataract**

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**Purpose:** To study eye movement abnormalities in a large group of children after the removal of unilateral infantile cataract, and to compare fixational instabilities between treatment groups with or without intraocular lens (IOL) implantation.

**Methods:** The Infant Aphakia Treatment Study (IATS) is a randomized, multicenter clinical trial comparing IOL to contact lens (CL) treatment in 114 infants with a unilateral infantile cataract who underwent cataract surgery at 1 to 6 months of age. During a study visit at age 4.5 years, eye movements were recorded using a high-speed video camera while the child fixated a target at 3 m. Recordings were filtered and digitized, then inspected by a masked examiner for the presence of fixational instabilities (nystagmus and saccadic oscillations).

**Results:** Not all scheduling was successful and not all recordings were scorable, resulting in data for 83 children. Overall, fixational instabilities were observed in 50 children (60%), with no differences between treatment groups (26 in the IOL group, 24 in the CL group; Fisher’s exact test, P=0.82). Nystagmus was seen in 38% and saccadic oscillations in 31%, with no differences between treatment groups (P=0.49 and 0.33, respectively).

**Conclusions:** Nystagmus and saccadic oscillations are well-known consequences of infantile cataracts, presumably the result of visual deprivation during the critical period of visual development. After early cataract extraction, successful optical correction should reduce further form deprivation and minimize the incidence of these fixational instabilities. In this study, no differences in the presence of fixational instabilities were found between the two initial strategies (CL or IOL) for optical correction after cataract removal.

**Commercial Relationships:** Joost Felius, None; Claudio Busettini, None; Scott R. Lambert, None; Michael J. Lynn, None; E Eugenie Hartmann, None

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**Clinical Trial:** NCT00212134