Purpose: To evaluate pediatric patients with unilateral or bilateral anterior polar cataracts and assess the development of astigmatism, rate of amblyopia, change in visual acuity, and need for surgery over time.

Methods: A retrospective chart review was performed on patients examined at Texas Children’s Hospital in Houston, Texas from 2008 to 2014. Patients with unilateral or bilateral anterior polar cataracts (APCs) were included in the study. Patients with mixed etiology cataracts or other causes of poor visual acuity were excluded. Size, location, and type of anterior polar cataract were assessed.

Best corrected visual acuity and refraction were recorded from the initial visit and subsequent encounters. Development of amblyopia, anisometropia, and astigmatism were recorded. Size and type of cataract were correlated with the development of each outcome. Statistical analysis was performed on each categorical variable with significance set at p < 0.05.

Results: A total of 31 patients were included in the study. 17 patients had unilateral APCs and 14 had bilateral APCs. 83% were centrally located and 17% were non-central. 40% of patients had concurrent ocular conditions and 10% had systemic associations. 21% of patients with bilateral cataracts developed amblyopia compared to 35% in the unilateral population. 29% of patients with bilateral cataracts had anisometropia compared to 24% in the unilateral population. 3 patients required surgical intervention.

Conclusions: Most anterior polar cataracts are less than 1 mm in size and of the polar type. Risk of amblyopia is higher than the general population. Anisometropia is the most common cause of amblyopia. Ocular and systemic associations can occur but are uncommon. Surgical treatment is uncommon; however, growth of APCs, pyramidal type, and associated cortical changes may be risk factors for surgery.

Commercial Relationships: Lena Dixit, None; Michael Puente, None; Kimberly Yen, None

Program Number: 2184 Poster Board Number: B0037
Presentation Time: 3:45 PM–5:30 PM

The effects of Monocular Training on Binocular Functions in Adult Amblyopia

Chang-Bing Huang, Wuli Jia, WUXIAO ZHAO, Zhong-Lin Lu.
1Institute of Psychology, CAS, Beijing, China; 2Department of Psychology, The Ohio State University, Columbus, OH; 3Center for Optometry and Visual Science, The People’s Hospital of Guangxi Zhuang Autonomous Region, Nanning, China.

Purpose: It’s now clear that intensive monocular perceptual learning can improve visual acuity, contrast sensitivity, and vernier acuity in the amblyopic eye of adults with amblyopia. It is however not clear how much monocular training can enhance binocular vision. In the current study, we aimed to determine the effects of monocular training on a variety of binocular visual functions.

Methods: Eleven adults with anisometropic amblyopia (22±1.4 yrs) were trained in a grating contrast detection task near each individual’s cutoff spatial frequency for 8 to 10 days, with 630 trials/day. Visual acuity, stereo acuity, monocular and binocular contrast sensitivity functions (CSF) with the quick CSF method (Lesmes, et al., 2010), perceived phase of binocularly combined sinewave gratings as a function of interocular image contrast ratio (Huang et al., 2009), pAE dominance in viewing dichoptically presented incompatible images of equal contrasts were measured before and after training.

Results: Training substantially improved contrast sensitivity at the trained spatial frequency (by 75.4%), area under the CSF (by 94%), and visual acuity (logMAR from 0.62 to 0.42 or 2 lines) in the amblyopic eye. It also significantly improved stereo acuity (from 1530.9” to 110.7”) and increased the dominance duration of the amblyopic eye (from 2% to 13% in binocular rivalry). The improved dominance of the amblyopic eye was through elongation of each dominant phase without alteration of the switching frequency between the two eyes. On the other hand, training didn’t significantly improve the ratio of the areas under binocular and monocular fellow eye CSFs (from 1.1 to 1.08, p>0.1) and the interocular contrast ratio at which the two eyes contribute equally to binocular phase combination (from 0.11 to 0.13, p>0.10). There is no significant correlation between improvements in visual acuity, stereo acuity, and binocular rivalry.

Conclusions: Although monocular training can improve visual acuity and contrast sensitivity and eye dominance of the amblyopic eye, the magnitudes of improvements didn’t correlate with each other; the impact on binocular summation and binocular phase combination was not significant. The results strongly suggest that structured monocular and binocular training is necessary to fully recover deficient visual functions in amblyopia.

Commercial Relationships: Chang-Bing Huang, None; Wuli Jia, None; WUXIAO ZHAO, None; Zhong-Lin Lu, Adaptive Sensory Technology, LLC. (I), The Ohio State University (P)

Support: Supported by National Natural Science Foundation of China (NSFC 31230032 and 31470983), the Knowledge Innovation Program of the Chinese Academy of Sciences (Y3C1X010203), Institute of Psychology, CAS to Chang-Bing Huang, and NEI (EY021553) to Zhong-Lin Lu.

Program Number: 2185 Poster Board Number: B0038
Presentation Time: 3:45 PM–5:30 PM

A Randomized Trial of Amblyz™ Intermittent Occlusion Glasses vs Traditional Patching for Treating Children with Moderate Unilateral Amblyopia

Jingyun Wang, Daniel Neely, Jay Galli, Joshua Schliesser, Tina Damarjian, Heather Smith, Dana Donaldson, Kathryn M. Haider, Derek Sprunger, David Plager. Glick Eye Institute, Department of Ophthalmology, Indiana University School of Medicine, Indianapolis, IN.

Purpose: PEDIG studies suggest a 2-hour patching treatment is effective for children with moderate amblyopia. AmblyzTM liquid crystal occlusion glasses are able to occlude the eye intermittently for periods of 30 seconds. Therefore, we hypothesized that 4-hour daily intermittent occlusion from AmblyzTM glasses is equally effective to 2-hour daily patching occlusion. Although a previous non-randomized pilot study suggested that liquid crystal occlusion glasses are effective treating amblyopia (Spierer et al. 2010), there has not been prior comparison to a patching control group. This randomized clinical trial is designed to compare the effectiveness of AmblyzTM.
Compliance with Amblyz™ glasses is similar to patching, even when wearing time was doubled in this trial. This device promotes a relatively comfortable experience for the child and is a promising alternative to the traditional patching treatment.

**Commercial Relationships:** Paxton Ott, None; Daniel Neely, None; Jingyun Wang, None; Jay Galli, None; Heather Smith, None; Dana Donaldson, None; Kathryn M. Haider, None; Derek Sprunger, None; David Plager, None

**Clinical Trial:** NCT01973348

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**Program Number:** 2187 **Poster Board Number:** B0040

**Presentation Time:** 3:45 PM–5:30 PM

Feasibility Study in Normal Children of a Liquid Crystal Spectacle Filter (LCSF) for Potential Treatment of Amblyopia

**Methods:** Alpha Micron Inc. Kent, Ohio, has developed a liquid crystal system designed specifically for eyewear which uses a polymer liquid crystal mixture consisting of “guest” monomers in a liquid crystal “host”. This mixture is sandwiched between two curved flexible plastic substrates coated with transparent electrodes. By applying voltage to the substrates, the electro-optic response of the liquid crystal mixture is used to control the opacity of the device. The voltage is applied manually with a touch of a button or automatically through a sensor, providing instantaneous control over transmission. 20 normal children ages 7-10 were testing while wearing the LCSF. The amount of light transmission measure as a voltage was correlated to monocular and binocular visual acuity degradation using the PEDIG acuity testing paradigm.

**Results:** The LCSF is successfully able to depress visual acuity in a linear fashion by changing the “haze” or light transmission function in a stepwise fashion from 20/20 to light perception.

**Conclusions:** The LCSF filter may provide multiple benefits in the treatment of, including; ease of application to commercially available eyewear, cosmetic appeal, comfort, versatility in occlusion dosage and the potential to improve adherence.

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**Program Number:** 2186 **Poster Board Number:** B0039

**Presentation Time:** 3:45 PM–5:30 PM

Compliance with Amblyz™ Liquid Crystal Glasses Versus Traditional Adhesive Patches

**Methods:** Children (N=28, age=5.3±1.4YR, 3- to 8-year-old) with previously untreated, moderate, unilateral amblyopia (visual acuity of 20/40 to 20/100 in the amblyopic eye) were enrolled. All subjects had worn optimal refractive correction (if needed) for at least 12 weeks without improvement and their amblyopia was associated with strabismus, anisometropia, or both. Subjects were randomized into one of two treatment groups: a 4-hour Amblyz™ Glasses Group, or a 2-hour Patching Control Group. After 12 weeks, compliance was reported with a calendar log and an Amblyopia Treatment Index (ATI) questionnaire characterizing the experience. Weekly compliance was calculated using the total weekly-treated minutes divided by the total weekly-prescribed minutes.

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This is the LCSF prototype showing full light transmission above and no light transmission below.

This curve shows the relationship between light transmission and visual acuity.

**Commercial Relationships:** Megan Cochran, None; Richard W. Hertle, None; Paul Luchette, Alpha Micron (E); Kajal Jassemnejad, Alpha Micron (E); Sandip Bhatta, Alpha Micron (E); Tamas Kosa, Alpha Micron (E); Bahman Taheri, Alpha Micron (E); Volodymyr Bodnar, Alpha Micron (E)

**Program Number:** 2188 **Poster Board Number:** B0041  
**Presentation Time:** 3:45 PM–5:30 PM

**Objective compliance, dose, and response for atropine penalization amblyopia treatment**

Scott O’Brien, Lyne Racette, Heather Smith, Kathryn M. Haider, Dana Donaldson, Derek Sprunger, Daniel Neely, David Plager, Jingyun Wang. Glick Eye Institute Department of Ophthalmology, Indiana University School of Medicine, Indianapolis, IN.

**Purpose:** According to previous studies, a daily regimen (7 drops a week) of atropine penalization is equally effective to a 2-drop regimen (2 drops a week) in treating moderate and severe amblyopia. These results suggest that the dose-response relationship of atropine penalization is not fully understood. Parental self-reported subjective compliance to atropine penalization ranges from 59% to 94%. (PEDIG, 2002, 2008, 2009) Objective measurement of compliance to atropine penalization has not been reported. This study aims to investigate objective compliance, dose, and vision improvement response to atropine penalization in amblyopic children.

**Methods:** Twelve amblyopic children (3-8yr; 20/40-20/125 in the ambyopic eye, not previously treated with atropine) were enrolled. Twice weekly or daily regimen was prescribed by physicians. To measure objective compliance, we used Medication Event Monitoring System (MEMS) caps, which are designed to record the time and date when the bottle was opened. Objective compliance was calculated as the ratio of MEMS weekly recording times to regimen had significantly higher objective compliance than the daily regimen (p=0.03). Visual acuity in the amblyopic eye improved 0.23±0.18logMAR. Data suggests that visual acuity improvement is correlated to total atropine usage (R-squared =0.73), instead of regimen (R-squared =0.10).

**Conclusions:** Objective compliance with atropine instructions can be monitored with MEMS, which may facilitate more effective communication between clinicians and patients. Our pilot data showed that objective compliance with atropine penalization treatment decreases over time and varies with regimen. On average, subjective parental reporting of compliance is overestimated.

**Commercial Relationships:** Scott O’Brien, None; Lyne Racette, None; Heather Smith, None; Kathryn M. Haider, None; Dana Donaldson, None; Derek Sprunger, None; Daniel Neely, None; David Plager, None; Jingyun Wang, None

**Support:** Indiana CTSI PDT

**Program Number:** 2189 **Poster Board Number:** B0042  
**Presentation Time:** 3:45 PM–5:30 PM

**Problems in occlusion therapy – a qualitative study with parents and educators**

Charlotte Schramm, Sybille Graef, Natalia Radionova, Monika A. Rieger, Dorothée Besch, Kai Januschowski. Ophthalmology, University hospital, Tuebingen, Germany; Institute for Occupational, Social Medicine and Health Services Research, Tuebingen, Germany.

**Purpose:** The main problem while treating amblyopia (weak-sightedness) is compliance of both - children and parents.

- to occlusion instructions/ guidelines. The aim of this study is a description of the current situation and problems of occlusion therapy in Germany using structured interviews.

**Methods:** We performed 25 single structured interviews with adults who are involved in occlusion therapy as parents, educators or former patients who were treated with occlusion therapy in their childhood. Interviews were performed with persons of each of the following groups: parents and day-care workers of children with well-functioning therapy as well as parents and day-care workers of children with mal-functioning therapy and adults who received an occlusion therapy themselves in their childhood. The interview partners were recruited over the outpatient clinic in the University Eye Clinic Tuebingen, Department for strabology, motility disorders and children diseases. For the interviews standardized questions were used and different sociodemographic data according to the interview partner assessed additionally. Qualitative data analysis was carried out using Mayring’s content analysis method.

**Results:** The analysis shows that occlusion therapy works fine in public day-care centers in spite of the anxiety of the most parents. In the age of 2 to 6 years social discrimination or isolation is not common. But an important point and potential pitfall in therapy compliance is the missing information about amblyopia of day-care workers. Day-care workers in Germany are officially not authorized care about the children’s health issues like administering drugs. However, the interviewed day-care workers felt responsible and coped well with patching therapy. The social background of the patients seems not to have an impact on dealing with occlusion therapy.

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Conclusions: Against current view performing occlusion therapy in day-care centers is a good alternative to patching at home. This is important considering that mothers tend to return to their working life soon following childbirth. Therefore day-care is more and more carried out in different forms (like kindergarten or nanny) and an official authorization for day-care workers to care about the childrens’ health issues has to be politically discussed. Moreover, a better information of day-care workers about occlusion therapy is necessary.

Commercial Relationships: Charlotte Schramm, None; Sybille Gräf, None; Natalia Radionova, None; Monika A. Rieg, None; Dorothea Besch, None; Kai Januschowski, None

Support: This study was supported by an external peer reviewed funding of the “Nachwuchsfakademie Versorgungsforschung Baden-Wuerttemberg”

Purpose: Studies suggest binocular video game therapies may effectively treat amblyopia in older children and adults, who are outside the critical window for traditional patching. Dichoptic video game training involves complementary game elements shown to both eyes, with the amblyopic eye seeing a higher contrast image. We are evaluating the safety and efficacy of a new immersive virtual reality (VR) system as a dichoptic amblyopia therapy. An additional study aim is to validate at home VR-based therapy and to compare visual parameters with in-office clinical examinations.

Methods: We are conducting a single-center, masked, placebo-controlled study of the effect of 3-dimensional, VR gameplay on visual acuity (VA) and stereopsis in subjects with amblyopia. Approximately 50 participants between the ages of 15 and 45 with moderate vision loss from anisometropic and/or strabismic amblyopia are being enrolled. Subjects are randomized into three arms, comparing at-home dichoptic gameplay to monocular patching or binocular non-dichoptic gameplay. After an initial three-week period of patching or gameplay at home, all subjects receive the dichoptic intervention for an additional three weeks. Office-based testing is supplemented with novel in-game at-home diagnostic testing and compliance monitoring. Durability of treatment will be evaluated six months after enrollment. Primary study outcomes are VA in the amblyopic eye and stereopsis. Secondary outcomes include quality of life (AS-20 questionnaire), binocular Sloan low contrast acuity, and safety.

Results: Pilot data supports a beneficial effect in amblyopic patients, with reduced suppression after 3 hours of gameplay. More than 300 users have trialed this system without reporting persistent diplopia or other bothersome side effects. In control subjects with varied levels of vision, measures of acuity and stereopsis from clinical examinations correlate with in-game testing metrics.

Conclusions: Dichoptic VR treatment may be safe and effective in reducing suppression in young adults with amblyopia. Our randomized-controlled study will formally test the effects of dichoptic VR therapy on VA and stereopsis. Home-based VR systems also enable remote diagnostics and monitoring and should encourage compliance. Our initial results also support a role for remote testing in rigorous studies of candidate vision therapies.

Commercial Relationships: Christopher M. Aderman, None; Michael Deiner, None; Manish Gupta, Apollo VR (I); James Blaha, Apollo VR (I); Marc H. Levin, None

Clinical Trial: NCT02246556
Rebecca Camilleri1, Andrea Pavan2, Alessandro Galan1.
Psychology, University of Padova, Padova, Italy; 2Institut fur Experimentelle Psychologie, University of Regensburg, Regensburg, Germany.

Presentation Time: 3:45 PM–5:30 PM
Program Number: 2193 Poster Board Number: B0046

Improving visual functions in adult amblyopia with combined perceptual training and transcranial random noise stimulation (tRNS): a pilot study

Antonella Veronese1, Giuseppe Lo Giudice1, Gianluca Campana2, Rebecca Camilleri2, Andrea Pavan2, Alessandro Galan3.
1Ophthalmology, San Antonio Hospital, Padova, Italy; 2General Psychology, University of Padova, Padova, Italy; 3Institut fur Experimentelle Psychologie, University of Regensburg, Regensburg, Germany.

Purpose: to assess whether a much shorter perceptual training regime, in association with high-frequency transcranial electrical stimulation (hf-tRNS), was able to improve visual functions in a group of adult participants with amblyopia.

Methods: Seven participants with anisometropic amblyopia were recruited at the San Paolo Ophthalmic Center of San Antonio Hospital (Padova, Italy). The participants were enrolled in a 2-week (8 sessions) behavioural training programme using a contrast detection task under lateral masking conditions combined with online high frequency tRNS (hf-tRNS). All pre/post tests were administered monocularly on either eye and with the best optical correction. Perceptual training was also administered monocularly on the amblyopic eye with the best optical correction.

Exclusion criteria included any other ocular condition or cause for reduced VA other than amblyopia, myopia, presbyopia, hypermetropia and/or astigmatism; these include diabetes mellitus, pregnancy, presence of myopia-related ocular complications and any previous ocular surgery. Exclusion criteria also included incompatibility with transcranial electrical stimulation, as assessed with a questionnaire (e.g. history of seizures, skin problems, migraine, etc.). This study has been approved by the local Ethics Committee.

Results: VA and CS data were analysed with a repeated measures ANOVA with Time (pre- vs. post-test), and Spatial Frequency (only for CS: 0.8, 2.9, 5.8, 9.7, and 14.5 cpd) as within-subjects factors, and Eye (amblyopic/trained vs. non-amblyopic/untrained) as a between-subjects factor. Following eight sessions of a contrast detection training with lateral masking, VA significantly improved in both trained and untrained eye (F(1,8)=35.4, p<0.001, ηp²=0.75). The VA in the trained and untrained eye was also significantly different (F(1,12)=22.12, p<0.001, ηp²=0.65). CS significantly improved after training (F(1,12)=11.7, p=0.005, ηp²=0.49), regardless the eye (interaction Time by Eye: F(1,12)=0.3, p=0.87, ηp²=0.02)

Conclusions: In our small sample of participants, a short (8 sessions) contrast detection training under lateral masking conditions and concurrent hf-tRNS was able to increase mean VA by 0.18 LogMAR (53% improvement, ranging from 25% to 111%) in the trained amblyopic eye. The CS also resulted in strong improvements following training.

Commercial Relationships: Antonella Veronese, None; Giuseppe Lo Giudice, None; Gianluca Campana, None; Rebecca Camilleri, None; Andrea Pavan, None; Alessandro Galan, None
have introduced the concept of total effective dose of occlusion: the total dose a patient requires of occlusion before it stops being effective. Total effective dose depends on the patient’s residual amblyopia, amblyopia type, and age at the start of occlusion therapy. Dose-rates prescribed range from 2.5 to 12 hours/day.

Figure 1: Average daily dose rate and (transformed) total effective dose

Commercial Relationships: Laura Smith, None; Catherine Stewart, None; Alistair R. Fielder, None; Merrick J. Moseley, None; Michael Wallace, None
Support: NIHR RFPB Grant PB-PG-0808-16087

Program Number: 2195 Poster Board Number: B0048
Presentation Time: 3:45 PM–5:30 PM
A new anti-suppression approach to treating anisometropic amblyopia
Ying Yuan1, MIN LI1, Jiangnan He2, Bilian Ke2. 1Ophthalmology, Shanghai First People’s Hospital of Shanghai Jiaotong University, Shanghai, China; 2Shanghai Eye Diseases Prevention & Treatment Center, Shanghai, China.

Purpose: To evaluate the efficacy of Eyetronix Flicker Glass therapy in treating anisometropic amblyopia by breaking interocular suppression and promoting binocular fusion.

Methods: Thirty subjects with anisometric amblyopia, ages 7 to 13, were enrolled in this study. A novel stimulus of Eyetronix Flicker Glass, a lightweight spectacle frame with liquid crystal lenses that provide direct square-wave alternating occlusion, was used at a pre-programmed temporal frequency of 7 Hz. Visual acuity, contrast sensitivity (CSV-1000E charts) of 3, 6, 12 and 18 cycles per degree spatial frequencies showed significant improvement at the visits of 3, 6, 9 and 12 weeks. Mean stereoacuity (Tirum test) improved from 241 seconds to 80 seconds. Stereocuity in 11/30 children recovered to 60 seconds. In addition, there was a decreased P100 latency and increased N75-P100 amplitude of visual averted potential after treatment.

Conclusions: EyeTeronix Flicker Glass showed promise as an alternative method for amblyopia treatment. It was effective in improving both monocular and binocular function, likely by reducing suppression and stimulating recovery of the visual cortex.

Commercial Relationships: Ying Yuan, Eyetronix, Inc (F); MIN LI, Eyetronix, Inc (F); Jiangnan He, None; Bilian Ke, Eyetronix, Inc (F)
Support: Grant No.81200713; Grant No.12RC06; Grant No.070339
Clinical Trial: 2013-010

Program Number: 2196 Poster Board Number: B0049
Presentation Time: 3:45 PM–5:30 PM
The relationship between fusion, suppression, and diplopia in amblyopia
Daniel P. Spiegel1, Alex S. Baldwin1, Mark A. Georgeson2, Reza P. Farivar3, Robert F. Hess1. 1Ophthalmology, McGill University, Montreal, QC, Canada; 2Vision Sciences, Aston University, Birmingham, United Kingdom.

Purpose: Traditionally, it has been thought that no binocular combination occurs in amblyopia. However, there is a growing body of evidence that there are intact binocular mechanisms in amblyopia rendered inactive under normal viewing conditions due to imbalanced monocular inputs. Georgeson and Wallis (2014) recently introduced a novel method to investigate fusion, suppression and diplopia in normal population. We have modified this method to assess binocular interactions in amblyopia.

Methods: Ten amblyopic and ten control subjects viewed briefly-presented (200 ms) pairs of dichoptically separated horizontal Gaussian blurred edges. Subjects reported one central edge, one offset edge, or a double edge as the vertical disparity was manipulated. The experiment was conducted at a range of spatial scales (blur widths of 4, 8, 16, and 32 arc min) and contrasts. Our model, based Georgeson and Wallis (2014), converted subjects’ responses into probabilities of fusion, suppression, and diplopia.

Results: When the normal participants were presented equal contrast to each eye the probability of fusion gradually decreased with increasing disparity, as the probability of diplopia gradually increased. In only a small proportion of the trials, normal participants experienced suppression. The pattern was consistent across all edge blurs. Interestingly, the majority of amblyopes had a comparable pattern of fusion, i.e. decreasing probability with increasing disparity. However, with increasing disparity the amblyopes tended to suppress the amblyopic eye, experiencing diplopia only in a small proportion of trials particularly at large blurs. Increasing the interocular contrast offset favouring the amblyopic eye normalized the pattern of data in a way similar to normal participants. There were some interesting exceptions: strong suppressors for which our contrast range was inadequate and one case in which diplopia dominated.

Conclusions: This task is suitable for assessing binocular interactions in amblyopic participants and providing a way to quantify the relationship between fusion, suppression and diplopia. In agreement with previous studies, our data indicate the presence of binocular mechanisms in amblyopia. A contrast offset favouring the amblyopic eye normalizes the measured binocular interactions in the amblyopic visual system.

Commercial Relationships: Daniel P. Spiegel, None; Alex S. Baldwin, None; Mark A. Georgeson, None; Reza P. Farivar, None; Robert F. Hess, None
Interocular Suppression and Treatment of Childhood Amblyopia
Sarah E. Morale, Simone L. Li, Reed M. Jost, Angie De La Cruz, David Stager, Lori Dao, Eileen E. Birch.

**Purpose:** New techniques for measuring depth of interocular suppression make it possible to quantify the relationship between suppression and monocular visual deficits in amblyopia. Here, we investigate the effects of treatment on interocular suppression and its relationship to changes in visual acuity in ambyopic children.

**Methods:** 121 children (5-12y) with strabismus, anisometropia, or both were tested; 71 were amblyopic, 24 were never amblyopic, 26 had recovered from amblyopia with treatment. Depth of interocular suppression was measured with a dichoptic motion coherence task. Best-corrected visual acuity (BCVA) was measured with ATS-HOTV.

**Results:** Mean (± s.e) DT for strabismic and/or anisometropic children who were never amblyopic was 84±3 %C and for those who had recovered was 69±6 %C. There was no significant difference in DT between strabismic and anisometropic amblyopia (49±5 vs 55±4 %C; p=0.36). DTs for amblyopic children being treated with glasses (45±4 %C) and those being treated with patching + glasses (35±5 %C; p=0.0001) were significantly lower than both nonamblyopic groups (p<0.001). DT for amblyopic children participating in binocular treatment (Li et al Eye 2014; Birch et al JAAPOS in press) was not significantly different from the recovered group (68±6 %C; p=0.90) but was significantly higher than the patching + glasses group (p<0.0001). For 30 children who had 2 visits, including 3 with recurrent amblyopia, 17 with stable BCVA, and 10 with BCVA improvement, the change in DT was correlated with the change in BCVA (r=-0.47; p=0.009).

**Conclusions:** The weakened response for the non-deprived eye during and immediately after patching was striking. It cannot be explained by adaptation in the eye or cortex. We have now observed electrophysiologically a corresponding alteration of interocular balance at the single cell level. These results confirm the previous psychophysical studies and suggests a dynamic mechanism for regulating interocular balance and gain, one that is likely cortical in origin.

**Commercial Relationships:** Sarah E. Morale, None; Simone L. Li, None; Reed M. Jost, None; Angie De La Cruz, None; David Stager, None; Lori Dao, None; Eileen E. Birch, None

**Support:** NEI Grant EY022313

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Short-term monocular deprivation reveals rapid shifts in interocular balance and gain in adult macaque visual cortex
Momotaz Begum, Daniel Y. Tso.

**Purpose:** Short-term monocular deprivation (STMD, patching one eye for 2.5 hours) markedly alters interocular balance in adult humans, as measured psychophysically (Lunghi et al 2011; Zhou et al 2013). In those studies, the relative contribution of the patched eye was elevated for more than an hour after patch removal. Now using intrinsic optical imaging in anesthetized macaque primary visual cortex (V1), we sought a parallel impact of STMD on interocular balance as measured by the strength of the V1 ocular dominance columns (ODC). Single-unit recordings in V1 with STMD, explored the neural correlates of these changes interocular balance at the neuronal level.

**Methods:** Optical imaging of V1 provided an initial ODC map for the imaging studies, and to guide the placement of single-unit electrodes. After measuring the baseline monocular and binocular responses, one eye was “deprived” by viewing a mean gray screen while the other eye continued to view the same stimuli and imaging or electrophysiological recordings proceeded. This MD phase lasted 2 hours, then visual stimuli and imaging or recordings continued another 2 hours.

**Results:** The imaging data were analyzed for ODC maps and for ODC signal strength (fractional reflectance change). Single cell responses to monocular and binocular stimuli were plotted before, during and after STMD. During STMD, the imaging data showed a steady decrease in the non-deprived eye strength, which dramatically shifted course (increased) after STMD even though stimulus in this eye was unaltered. The single-unit recordings revealed several different types of cell responses, including cells that showed unremarkable shifts in responses due to the STMD, other cells that exhibited an apparent strengthening of the non-deprived eye during STMD, and cells where the non-deprived eye showed dramatic drops in responsivity during STMD, consistent with the observed imaging (and psychophysical) results.

**Conclusions:** The weakened response for the non-deprived eye during and immediately after patching was striking. It cannot be explained by adaptation in the eye or cortex. We have now observed electrophysiologically a corresponding alteration of interocular balance at the single cell level. These results confirm the previous psychophysical studies and suggests a dynamic mechanism for regulating interocular balance and gain, one that is likely cortical in origin.

**Commercial Relationships:** Momotaz Begum, None; Daniel Y. Tso, None

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Dynamic regulation of synapsin phosphorylation by monocular deprivation in mice
Tao Fu, Qing Su, Jing Wang, Song Han, Junfa Li.

**Purpose:** Short-term monocular deprivation (STMD, patching one eye for 2.5 hours) markedly alters interocular balance in adult humans, as measured psychophysically (Lunghi et al 2011; Zhou et al 2013). In those studies, the relative contribution of the patched eye was elevated for more than an hour after patch removal. Now using intrinsic optical imaging in anesthetized macaque primary visual cortex (V1), we sought a parallel impact of STMD on interocular balance as measured by the strength of the V1 ocular dominance columns (ODC). Single-unit recordings in V1 with STMD, explored the neural correlates of these changes interocular balance at the neuronal level.

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**Results:** The imaging data were analyzed for ODC maps and for ODC signal strength (fractional reflectance change). Single cell responses to monocular and binocular stimuli were plotted before, during and after STMD. During STMD, the imaging data showed a steady decrease in the non-deprived eye strength, which dramatically shifted course (increased) after STMD even though stimulus in this eye was unaltered. The single-unit recordings revealed several different types of cell responses, including cells that showed unremarkable shifts in responses due to the STMD, other cells that exhibited an apparent strengthening of the non-deprived eye during STMD, and cells where the non-deprived eye showed dramatic drops in responsivity during STMD, consistent with the observed imaging (and psychophysical) results.

**Conclusions:** The weakened response for the non-deprived eye during and immediately after patching was striking. It cannot be explained by adaptation in the eye or cortex. We have now observed electrophysiologically a corresponding alteration of interocular balance at the single cell level. These results confirm the previous psychophysical studies and suggests a dynamic mechanism for regulating interocular balance and gain, one that is likely cortical in origin.

**Commercial Relationships:** Momotaz Begum, None; Daniel Y. Tso, None

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Purpose: To investigate the dynamic changes of isoform-specific protein expression and phosphorylation of synapsins in visual cortex of the postnatal mice with monocular deprivation (MD).

Methods: Forty-two clean neonatal C57BL/6J mice were divided into seven groups randomly and six for each group. The mice were sacrificed to obtain the tissue samples at postnatal 7, 14, 21, 28, 35, 42, 60 days respectively. Similarly, Thirty neonatal healthy C57BL/6J mice were divided into five groups randomly (Monocular Deprivation groups, MD groups) and six for each group. The right eyelids of MD groups were sutured at postnatal 14, 21, 28, 35, 60 days respectively, and sacrificed after 7 days to obtain the tissue samples. Western blot were applied to quantitatively analyze the level of Synapsin phosphorylation and protein expression in the visual cortex.

Results: The results showed that the total (T-) protein levels of synapsins including the isoform of Ia/b, IIa/b and IIIa were about 21-26% of adult level in visual cortex of mice at postnatal 7 days (P7), and then the T-synapsin Ia/b and Iib could quickly reach adult level at P35. However, the T-synapsin IIa and IIIa increased more slowly (71-74% at P35), and then kept increasing in the visual cortex of mice at P60. Unlike to the changes of T-synapsins, the level of phosphorylated (P-) synapsin Ia/b (not IIa/b and IIIa) at site 1 increased with development to the highest level (286.6±16.7%) at P21, and then decreased rapidly to a low level in visual cortex of mice at P35-60. In addition, we found that the levels of P-synapsin Ia/b increased significantly (p<0.05, n=6 per group) in left visual cortex of P28 and P35 (not P21 and P42) mice with one-week MD of right eye; and no significant changes of T-synapsins were observed in both left and right sides of visual cortex in P21-42 mice with MD treatment.

Conclusions: These results suggested that the isoform-specific protein expression and site-1 phosphorylation of synapsins might play a different role in the synaptic plasticity of visual cortex, and monocular deprivation delays the dynamic changes of phosphorylated synapsin Ia/b at site-1 in contralateral visual cortex of juvenile mice.

Commercial Relationships: Tao Fu, None; Qing Su, None; Jing Wang, None; Song Han, None; Junfa Li, None

Support: NNSF of China 30600068; BNSF 7132057

Program Number: 2200 Poster Board Number: B0053
Presentation Time: 3:45 PM–5:30 PM
Effects of abnormal binocular vision due to amblyopia on early stages of somatosensory processing
Ewa Niechwiej-Szwedo, Christina Popovich, Jessica Chin, W. Richard Staines. Department of Kinesiology, University of Waterloo, Waterloo, ON, Canada.

Purpose: Abnormal visual experience during development results in amblyopia and/or strabismus and affects neural activity in the striate and extrastriate visual areas; however, no studies to date examined the effect of amblyopia on neurophysiological processing beyond the primary visual areas. Previous work with healthy adults has shown that crossmodal stimuli can modulate neural excitability at very early stages of information processing. For example, the amplitude of the early somatosensory event-related potential (ERP), P50, is significantly enhanced when a tactile stimulus is presented concurrently with a relevant visual stimulus. We hypothesised that altered neural excitability in the primary visual areas in amblyopia will alter crossmodal interactions in other brain regions.

Methods: Participants were three patients with amblyopia and five visually-normal adults. Crossmodal interaction was investigated during binocular viewing using EEG. Specifically, the P50 somatosensory ERP was recorded as participants engaged in a task which required discrimination of the amplitude of a tactile and visual stimulus. Tactile stimuli were discrete vibrations presented to the left index finger and visual stimuli were presented as a central horizontal bar on a computer screen. Participants executed a graded motor response with the right hand indicating the summation of the amplitude of the sensory inputs. Three experimental conditions were tested: unimodal (tactile only), bimodal concurrent (tactile and visual presented simultaneously), and bimodal priming (visual presented 100 ms prior to tactile).

Results: As hypothesized, patients showed no enhancement of the P50 amplitude in the bimodal conditions (unimodal: 2.97±0.40μV; bimodal concurrent: 1.86±0.84μV; bimodal priming: 1.94±0.81μV). In contrast, visually normal participants showed a significant enhancement of the P50 amplitude in the bimodal condition (unimodal: 2.07±0.33μV; bimodal concurrent: 2.46±0.34μV; bimodal priming: 2.32±0.50μV), which is consistent with the previous study.

Conclusions: Preliminary results indicate that early crossmodal facilitation is affected by abnormal visual experience during development. Thus, this study offers the first evidence that the consequences of amblyopia on neurophysiological processing extend beyond the primary visual areas.

Commercial Relationships: Ewa Niechwiej-Szwedo, None; Christina Popovich, None; Jessica Chin, None; W. Richard Staines, None

Support: Canadian Foundation for Innovation and Ontario Research Fund

Program Number: 2201 Poster Board Number: B0054
Presentation Time: 3:45 PM–5:30 PM
Ocular Imbalance in Clinically Treated Amblyopia
Wuli Jia1, WUXIAO ZHAO1, Chang-Bing Huang1, Zhong-Lin Lu1. 1Institute of Psychology, Chinese Academy of Sciences, Beijing, China; 2Institute of Psychology, University of Chinese Academy of Sciences, Beijing, China; 3Center for Optometry and Visual Science, The People’s Hospital of Guangxi Zhuang Autonomous Region, Nanning, China; 4Laboratory of Brain Processes (LOBES), Departments of Psychology, The Ohio State University, Columbus, OH.

Purpose: The current gold standard of a successful amblyopia treatment is the full recovery of visual acuity in the amblyopic eye. Although anecdotal evidence suggests that other visual functions such as contrast sensitivity might still be deficient after full acuity recovery, there has been no systematic study on how the previously amblyopic eye (pAE) will behave in binocular vision. In this study, we aimed to quantify sensory dominance of the pAE in a group of treated amblyopia.

Methods: Eight treated amblyopes with very similar acuity in the two eyes (logMAR: .03 vs .00) participated in this study. Stereoacuity, monocular and binocular contrast sensitivity functions (CSF) with the quick CSF method (Lesmes et al., 2010), perceived phase of binocularly combined sinewave grating as a function of interocular contrast ratio (Huang et al., 2009), and pAE dominance in viewing dichoptically presented incompatible images of equal contrasts were measured. To quantify sensory eye dominance, we derived three different indices: (1) binocular contrast summation ratio: the ratio of the areas under binocular and previously fellow eye (pFE) CSFs, (2) balance point in binocular combination: the interocular contrast ratio at which the two eyes contribute equally to binocular phase combination, and (3) percentage of pAE dominance. The lower the binocular summation ratio and balance point, the weaker the pAE relative to the pFE is; a less than 0.5 eye dominance percentage indicates weaker pAE than pFE.

Results: Near stereo acuity (31.38±6.93") and pAE dominance percentage (.5 at 1 c/d and .43 at 8 c/d) of the treated amblyopes were...
labeled comparable to those of normal subjects. Contrast sensitivity remained deficient in high spatial frequencies, consistent with Huang et al. (2007), although their binocular contrast summation ratio (1.26±0.16) is only slightly less than that of normal subjects (Baker et al. 2007). However, the average balance point in binocular combination was only 0.41—the effective contrast of images in the pAE is equal to about 41% of the same contrast presented to the pFE in binocular phase combination. 

Conclusions: Although near stereocuity, binocular contrast summation ratio, and eye dominance in treated amblyopia were normal or nearly normal, the pAE remained “lazy” in binocular phase combination. Our results suggest that structured monocular and binocular training are necessary to fully recover deficient functions in amblyopia.

Commercial Relationships: Wuli Jia, None; WUXIAO ZHAO, None; Chang-Bing Huang, None; Zhong-Lin Lu, Adaptive Sensory Technology, LLC. (I), The Ohio State University (P)

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Program Number: 2202 Poster Board Number: B0055
Presentation Time: 3:45 PM–5:30 PM

Detection of Amblyopia using sweep VEP grating and vernier acuity

Chuan Hou1, William V. Good1, Anthony Norcia 1, 2

1 The Smith-Kettlewell Eye Research Institute, San Francisco, CA; 2Department of Psychology, Stanford University, Stanford, CA.

Purpose: Grating and vernier displacement thresholds can be measured with swept-parameter visual evoked potentials (sVEP) and may therefore be useful in pre- or nonverbal subjects. Psychophysical studies indicate that while both grating and vernier acuity are correlated with letter acuity, grating acuity underestimates the full-line letter acuity loss in amblyopia. This study was conducted to determine whether sVEP vernier acuity is better estimate of letter acuity than is sVEP grating acuity in patients with amblyopia.

Methods: 18 adults with amblyopia (8 anisometric and 10 strabismic) and 28 age-matched normal vision observers participated the study. In the patient group, letter acuity was between 20/32 and 20/250 in the amblyopic eye and 20/20 or better in the fellow eye when measured with a constant LogMar chart (Bailey-Lovie). In the normal vision group, letter acuity was 20/20 or better in each eye. sVEP vernier acuity was measured using square-wave gratings containing vernier displacements modulated at 3.76 Hz. sVEP grating acuity was measured using sine-wave gratings reversal at 7.5 Hz.

Results: As has previously been reported for psychophysical measurements of vernier and grating acuity, sVEP vernier acuity in both normal vision observers and ambylopic observers faithfully reflected the absolute magnitude of the Letter acuity, while sVEP grating acuity systematically over-estimated letter acuity in the amblyopic eye.

Conclusions: Because sVEP vernier acuity is a better estimate of the full letter acuity loss and can be measured without the need for instruction or behavioral responses, it may be useful in assessing visual function in pre- and nonverbal patients.

Commercial Relationships: Chuan Hou, None; William V. Good, None; Anthony Norcia, None

Support: The Smith-Kettlewell Eye Research Institute

Program Number: 2203 Poster Board Number: B0056
Presentation Time: 3:45 PM–5:30 PM

Normative Pediatric Data for Three Tests of Functional Vision

James R. Drover1, Shelley Cornick2, Ashley Drover2, Deanne Mayo1, Nadine Kielly1

1 Psychology and Pediatrics, Memorial University of Newfoundland, St. John’s, NF, Canada; 2 Psychology, Memorial University of Newfoundland, St. John’s, NF, Canada; 3 Private Practice Optometrist, St. John’s, NF, Canada.

Purpose: Tests of visual acuity, stereocuity, and refractive error are common components of preschool vision screening programs. An increasing number of these tests are becoming commercially available. The purpose of the present study is to provide the first normative pediatric data for three such tests, namely, the Precision Vision Acuity Testing (PVVT) system, the Pass Test 3 Stereo Test, and the Plusoptix S09 Vision Screener.

Methods: The participants included 267 children between the ages of 3 and 5 years (Mean = 4.2±0.8 years) participating in a preschool vision screening study. The children completed monocular testing with the PVVT system, a computerized test of visual acuity. The optotypes used were isolated Patti Pics symbols surrounded by crowding bars. Stereocuity was assessed using the Pass Test 3 Stereo Test, a random-dot test similar to the Random Dot E Stereo Test. Refractive error was measured using the Plusoptix S09 Vision Screener, which provides automatic, noncycloplegic estimates of refractive error. The mean and 95% tolerance limits were determined for each test.

Results: Visual acuity improved significantly from 0.32 logMAR at 3 years to 0.18 logMAR at 5 years (p<0.0001). The lower tolerance limit improved from 0.59 logMAR at 3 years to 0.38 logMAR at 5 years. Stereocuity also improved, decreasing from 120 arcsec (lower tolerance limit = 294 arcsec) at 3 years to 87 arcsec (lower tolerance limit = 220 arcsec) at 5 years (p = 0.0015). Spherical refractive error remained stable at 0.27D (lower tolerance limit in 3 years = 1.33D; lower tolerance limit at 5 years = 0.91D; p = 0.81), while cylindrical refractive error was also relatively stable, measuring 0.39D (lower tolerance limit = 1.00D) at 3 years and 0.37D (lower tolerance limit = 0.93D) at 5 years (p = 0.90).

Conclusions: Both visual acuity and stereocuity improved significantly from 3 to 5 years of age. Note however, the norms obtained using the PVVT system were somewhat lower than those reported in previous studies using different tests. The stability of spherical refractive error is unusual to some extent in that these children are undergoing emmetropization, but it does agree with a previous study providing noncycloplegic estimates of refractive error in children.

Commercial Relationships: James R. Drover, None; Shelley Cornick, None; Ashley Drover, None; Deanne Mayo, None; Nadine Kielly, None

Support: Canadian National Institute for the Blind New Researcher Award; Janeway Foundation Grant

Program Number: 2204 Poster Board Number: B0057
Presentation Time: 3:45 PM–5:30 PM

Identification of young children for participation in studies of spectacle correction through pediatric primary care clinics: A pilot study

Irene Campus1, Kimberly Gerhart2, Jordana M. Smith1, Amy Davis1, Joseph M. Miller1, Erin M. Harvey1

1 Ophthalm & Vision Science, University of Arizona, Tucson, AZ; 2 Pediatrics, University of Arizona, Tucson, AZ.

Purpose: To determine the true positive rate for children referred for eye examinations based on SPOT (Welch Allyn, Inc) photoscreening in pediatric primary care clinics.

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Methods: Children were screened at well-child checks with the SPOT photoscreener at one of three pediatric clinics. Screening failures were referred to the University of Arizona Visual Development Laboratory for follow-up eye examinations which included cycloplegic refraction and assessment of ocular alignment. Screening results were considered true positives if examination results met American Academy of Pediatric Ophthalmology and Strabismus (AAPOS) amblyopia risk factor referral criteria for children age 12 months and older.

Results: The final sample included 31 children ranging in age from 12 to 70 months who failed a SPOT screening conducted at their pediatric primary care clinic and completed an eye examination at the Visual Development Lab. Children failed the SPOT screening due to suspected astigmatism (24/31, 77%), anisometropia (5/31, 16%), hyperopia (2/31, 6%), and gaze asymmetry (2/31, 6%) (one child met criteria for astigmatism, hyperopia and anisometropia). Of the 31 children, 16 met AAPOS referral criteria based on eye examination results indicating a true positive rate of 52%. False positive rates were 10/24 (42%) for astigmatism, 1/2 (50%) for hyperopia, 4/5 (80%) for anisometropia, and 2/2 (100%) for gaze asymmetry.

Conclusions: Results indicate that approximately half of the children referred had significant refractive error. True positive referrals may be improved if primary care clinics repeat screenings to verify results before referring children. These preliminary data suggest that this method may be an efficient way to recruit subjects for clinical trials on refractive correction of young children. The primary care recruitment base will produce a study sample of previously untreated children that is more generalizable than samples recruited through ophthalmology/optometry clinics.

Commercial Relationships: Irene Campus, None; Kimberly Gerhart, None; Jordana M. Smith, None; Amy Davis, None; Joseph M. Miller, None; Erin M. Harvey, None

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Program Number: 2205 Poster Board Number: B0058
Presentation Time: 3:45 PM–5:30 PM

Refractive Change in Children with Accommodative Esotropia
Lucas Bonafede1, Lloyd Bender1, James Shaffer1, Gui-Shuang Ying2, Gil Binenbaum1,2

1Ophthalmology, The Children’s Hospital of Philadelphia, Philadelphia, PA; 2The Scheie Eye Institute, Perelman School of Medicine at the University of Pennsylvania, Philadelphia, PA.

Purpose: There is debate regarding the degree of change in refractive error over time in children with accommodative esotropia. We conducted a retrospective cohort study to determine whether there is a measurable change in hypermetropia in children with accommodative esotropia as they age.

Methods: We identified children with accommodative or partially accommodative esotropia diagnosed prior to age 7 years, followed to age 10 or older, and with at least two full cycloplegic refractions, one performed prior to age 7 years and one after age 10 years. Subjects who lacked refractive or orthoptic data, or had a concurrent ocular, motility, or systemic abnormality were excluded. The primary outcome was annual change in spherical equivalent refractive error calculated from linear mixed effect models with assessment for breakpoints based upon the annual changes. The annual change was further calculated during two periods (ages 3 to 7 years and ages 7 to 15 years) with subgroup analysis by baseline refractive error less than or greater than 4 diopters (D) of hypermetropia.

Results: 405 subjects met inclusion criteria. Mean age at first and last visit was 3.2 (SD 1.6) and 12.1 (SD 1.9) years, respectively, with the mean number of cycloplegic refractions being 7.6 (SD 2.5). Between ages 3 and 7, refractive error among children with baseline hypermetropia <4 D (n=176) increased by 0.14 D/year (95% CI +0.10 to +0.18), while refractive error was stable among children with baseline 4D or greater (n=229) whose annual change was 0.0 D/year (95% CI -0.03 to +0.04); the difference among groups was significant (p<0.001). Hypermetropia decreased from age 7 to 15 years in both subgroups: <4D subgroup -0.18 D/year (-0.21 to -0.16), 4D+ subgroup -0.20 D/year (-0.22 to -0.17)(comparison between subgroups p=0.527). There were no significant differences in refractive change between fully (n=274) and partially (n=131) accommodative esotropia (p=0.10).

Conclusions: Hypermetropia in children with accommodative esotropia is stable or increases up to age 7 years. Hypermetropia then decreases gradually between ages 7 and 15 years. However, the decrease in refractive error is not large for the great majority of children and is similar regardless of baseline refractive error.
Results: 492 children (244 hyperopes and 248 emmetropes) participated (mean age 58 months; mean [±SD] spherical equivalent refractive error +3.47D±0.81 in hyperopes and +0.37D±0.50 in emmetropes). Mean logMAR distance VA was better for emmetropes than hyperopes (0.10±0.11 vs. 0.19±0.10, p<0.001) and more emmetropes than hyperopes were able to achieve VA of at least 20/20 in the better seeing eye (53.6% vs. 21.4%, p<0.001). The mean logMAR VA at near in emmetropes was better than hyperopes (0.13±0.11 vs. 0.21±0.11, p<0.001), with 20/20 VA attained by 23.8% of emmetropes vs. 5.3% of hyperopes (p<0.001). Mean accommodative lag in emmetropes was smaller than in hyperopes for both MEM (1.0±0.5 vs. 2.0±1.0, p=0.001) and Grand Seiko (0.9±0.6 vs. 1.8±1.1, p<0.001). More emmetropes (59.3%) than hyperopes (16.4%) were able to achieve one of the two best tested stereacuity levels (30 or 40 sec arc, p<0.001). Mean stereacuity was better in emmetropes than hyperopes (67±60 sec arc vs.166±137 sec arc, p<0.001).

Conclusions: Visual function as measured with VA, accommodative response and stereocuity was significantly better in emmetropes compared to uncorrected hyperopes in this group of 4 to 5 year old children without strabismus or amblyopia. It is not known if correction of the hyperopia at this age improves these visual skills.

Commercial Relationships: Elise Ciner, None
Support: NIH/NEI R01 EY021141

Program Number: 2207 Poster Board Number: B0060
Presentation Time: 3:45 PM–5:30 PM
The Clinical Profile of Moderate Hyperopia in Children Three to Five Years of Age
Donny W. Suh1, Marjean T. Kulp2, Trevano W. Dean3, Raymond T. Kraker4, Sergul A. Erzurum5, David K. Wallace6, Yi Pang6, Caroline J. Shea7, John M. Avallone1. 1Department of Ophthalmology, University of Nebraska, West Des Moines, IA; 2College of Optometry, The Ohio State University, Columbus, OH; 3Jaeb Center for Health Research, Tampa, FL; 4Eye Care Associates, Youngstown, OH; 5Northeast Ohio Medical University, Rootstown, OH; 6Duke Eye Center, Durham, NC; 7Illinois College of Optometry, Chicago, IL; 8Providence Sacred Heart Medical Center, Spokane, WA; 9Ophthalmology Associates of Greater Annapolis, Arnold, MD.
Purpose: To describe relationships among baseline clinical findings in a cohort of children 3 to 5 years of age with moderate hyperopia participating in a 3-year randomized trial comparing glasses versus observation for development of amblyopia and strabismus.
Methods: 117 children 3 to 5 years of age with hyperopia in at least one eye between +3.00D and +6.00D spherical equivalent (SE), astigmatism ≤+1.50D in both eyes, and anisometropia ≤+1.50D SE based on cycloplegic refraction were enrolled. To be eligible, children had to have no measurable heterotropia, and could not have received previous treatment for refractive error, amblyopia, or strabismus. In addition, children had to 1) demonstrate age-normal monocular visual acuity (VA) uncorrected at distance in both eyes measured without cycloplegia, using the ATS-HOTV© VA testing protocol; 2) have ≤1 line of interocular difference; and 3) demonstrate age-normal stereoeacuity on the Randot Preschool Stereotest. Binocular near VA and monocular estimate method (MEM) dynamic retinoscopy were measured in a subset of subjects. Pearson correlation and partial correlation coefficients and 95% confidence intervals (CI) were calculated to evaluate relationships.
Results: The mean age was 4.42 years, and mean SE refractive error was +3.95D in the more hyperopic eye and +3.61D in the less hyperopic eye. Greater hyperopia at baseline was associated with greater accommodative lag as measured by MEM retinoscopy (R=0.31, 95% CI=0.05 to 0.53). Higher hyperopia at baseline was associated with worse distance VA, controlling for age (R=0.24, 95% CI=0.06 to 0.41). Better binocular near VA was associated with better monocular distance VA controlling for age (the correlation of near VA with distance VA was 0.35 (95% CI=0.16 to 0.51) in the better seeing eye and was 0.34 (95% CI=0.15 to 0.51) in the worse seeing eye). Better binocular near VA was also associated with better stereocuity (R=0.24, 95% CI = 0.04 to 0.42) controlling for age and anisometropia.

Conclusions: Weak to moderate associations exist among children enrolled with moderate hyperopia (+3.00D to +6.00D) and age-normal VA and stereocuity. As expected, greater hyperopia is moderately associated with greater accommodative lag and weakly associated with worse distance VA. Better binocular near VA is moderately associated with better monocular distance VA and weakly associated with better stereocuity.

Commercial Relationships: Donny W. Suh, None; Marjean T. Kulp, None; Trevano W. Dean, None; Raymond T. Kraker, None; Sergul A. Erzurum, None; David K. Wallace, None; Yi Pang, None; Caroline J. Shea, None; John M. Avallone, None
Support: NIH Grants EY018810, EY023198, and EY011751
Clinical Trial: NCT01515475

Program Number: 2208 Poster Board Number: B0061
Presentation Time: 3:45 PM–5:30 PM
Refractive errors in a rural population of Argentine Patagonia
Julio A. Urreos-Zavalía1, Leandro Correa1, Evangelina Esposito1, M. E. Gonzalez-Castellanos2, Dana Martinez2, fernanda Suarez2, Horacio M. Serra3. 1University Clinic R Fabiá/Ophtalmol, Universidad Catolica de Cordoba, Cordoba, Argentina; 2CIBICI-CONICET, Faculty of Chemical Sciences, Universidad Nacional de Cordoba, Cordoba, Argentina.
Purpose: Information of refractive errors prevalence in rural populations in Argentina is lacking. The purpose of our study was to assess the prevalence of refractive errors in an adult rural population living in an area of the Argentine Patagonia.
Methods: An observational, descriptive and retrospective study was performed to assess the frequency of myopia, hyperopia, astigmatism and anisometropia in 144 consecutive adult patients, 76 men and 68 women, of mapuche etnia from a rural region of the Argentine Patagonia. All patients received a comprehensive eye examination, including visual acuity with Snellen chart, and refraction was obtained under cycloplegia. Refractive errors were evaluated in spherical equivalent (SE). Myopia and hyperopia were defined as spherical equivalent (SE) ± 0.50. All patients with SE less than ±0.50D were considered as emmetropic. Astigmatism was defined as a cylinder equal or greater than 0.50D. Anisometropia was defined as the difference in spherical equivalent of ≥ 1.00D between the two eyes. Each refractive error was separated into three different groups: low (less than 1D), moderate (1-3D) and severe (>3D) astigmatism; low (<+2D), moderate (+2.25 to +5D) and severe (more than +5D) hyperopia; low (less than -3D), moderate (-3 to -6D) and severe (more than -6D) myopia. As the Spearman correlation coefficient for the SE and the cylinder between the right and left eye was high (r = 0.86, P <0.0001), only data from the right eye were used for analysis. Anisometropia was analyzed with SE data of both eyes. Variables with a p<0.05 were considered as significant.
Results: Median age was 55.5 years (r=20-84 years). The prevalence for emmetropia was 34% (95% CI = -0.38, 0.38); myopia 18% (95% CI = -21.25, -0.50), being more prevalent in women (p<0.001), much more frequently involved in near work tasks; hyperopia was 46.5% (95% CI = 0.5, 4.38); and astigmatism 63.2% (95% CI = 0.5, 5.5). Low (30.6%) and moderate (26.4%) astigmatism were more prevalent. 86.6% of hyperopic patients had low hyperopia.
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11.9% moderate and the 1.5% had severe hyperopia. Among myopic patients 73.1% had low, 11.5% moderate and 15.4% severe myopia. Anisometropia prevalence was 14.6% (95% CI = 1; 20.5).

**Conclusions:** Astigmatism, in particular low and moderate, was found to be highly prevalent among this rural population. Environmental factors and type of activity might contribute to astigmatism and myopia, respectively.

**Commercial Relationships:** Julio A. Urreets-Zavalia, None; Leandro Correa, None; Evangelina Esposito, None; M. E. Gonzalez-Castellanos, None; Dana Martinez, None; fernanda Suarez, None; Horacio M. Serra, None

**Program Number:** 2209 **Poster Board Number:** B0062
**Presentation Time:** 3:45 PM–5:30 PM

**Comparison of non-cycloplegic refraction with the PlusOptix A09 distance refraction and cycloplegic refraction.**

_Arnaud Payerols_1, _Claudie Malrieu-Eliaou_1, _Max Villain_1,2, _Vincent Daien_1,2 1.Ophthalmology, Gui de Chauliac Hospital, Montpellier, Montpellier, France; 2.Montpellier 1 University, Montpellier, France.

**Purpose:**

Accurate measurement of refraction in paediatric ophthalmology is mandatory. Cycloplegic refraction is the gold standard before first spectacle and during strabismus or amblyopia management. In this study we aimed to identify the distance refraction values as compared with non-cycloplegic refraction and cycloplegic refraction.

**Methods:**

A total of 32 children (corresponding to 64 eyes) ranging from 7 to 139 months of age where prospectively included. Before cycloplegic administration of 1% cyclopentolate hydrochloride, each child underwent refraction with the PlusOptix A09 and with the Retinomax hand-held or the Nidek autorefractor when possible. Same measurements were performed after cycloglia. Paired t-tests were used to compare spherical equivalent between each refraction. Pearson coefficients were used to correlate refraction values. The Bland-Altman method was used to assess the difference in refraction between distance PlusOptix A09 and cycloplegic refraction. Right eye was considered for all comparisons.

**Results:**

We observed significant differences of mean (interquartile range) spherical equivalent between classic refraction (-0.70 [-2.0;1.1] D) and PlusOptix A09 (+0.54 [-0.8;1.9] D), p=0.008 and between spherical equivalent from PlusOptix A09 (+0.54 [-0.8;1.9] D) and cycloplegic refraction (+1.06 [-0.4;2.0] D), p=0.02. The refraction value with the PlusOptix A09 was positively and significantly correlated to cycloplegic refraction (r =0.81, p<0.001). The mean difference between PlusOptix A09 and cycloplegic refraction was +0.52 (IC95: 0.10 - 0.93) and the limit of agreement range from -1.55 D to +3.15 D.

**Conclusions:**

This study documented the spherical equivalent value of non cycloplegic refraction performed with PlusOptix A09 that give closer value to cycloplegic refraction than classic refraction. Distance refraction can constitute a tool for screening or follow up that have higher value than classical non-cycloplegic refraction. However it cannot replace the cycloplegic refraction for first spectacle correction and during strabismus or amblyopia management.

**Commercial Relationships:** Arnaud Payerols, None; Claudie Malrieu-Eliaou, None; Max Villain, None; Vincent Daien, None

**Program Number:** 2211 **Poster Board Number:** B0064
**Presentation Time:** 3:45 PM–5:30 PM

**Validation of Confidence Levels for a Cell Phone-Based Refractor (NETRA-G)**

_Vitor F. Pamplona_1, _Steven Turpin_2, _Jorge Cuadros_2, _Rahul Modi_1 1.EyeNetra Inc, Somerville, MA; 2.University of California, Berkeley, Berkeley, MA.

**Purpose:** To assess the performance of a cell phone based refracting device (NET). We identify the efficacy of NET confidence values by comparing refractive differences between NET and subjective refraction (SR).

**Methods:** NET retrofits a high-resolution mobile phone (Samsung S4) by adding a pinhole mask and a lens onto the display. The

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Purpose: To investigate differences in the area of complete spatial summation (Ricco’s area) for standard perimetric stimuli, between amblyopic and control eyes. (Error bars: SEM)

Conclusions: NET’s confidence value can be used as a predictor for insufficient accuracy, triggering a retest or a discarding method. The low confidence group included the only 2 subjects with high-order aberrations and 5 subjects that required translation (a known language barrier for NET, since subjects need to understand the procedures). Group A included all subjects that could not reach 20/20 vision on the SR. The results show that NET has potential to be used as an effective tool for rapidly estimating refractive errors and interpupillary distance measurements.

Commercial Relationships: Vitor F. Pamplona, EyeNetra Inc (E); Steven Turpin, None; Jorge Cuadros, None; Rahul Modi, EyeNetra Inc (E)

Program Number: 2212 Poster Board Number: B0065
Presentation Time: 3:45 PM–5:30 PM

Spatial summation of perimetric stimuli across the visual field in anisometropic and strabismic amblyopia

Shindy Je, Fergal A. Ennis, James E. Morgan, Tony Redmond. School of Optometry and Vision Sciences, Cardiff University, Cardiff, United Kingdom.

Purpose: To investigate differences in the area of complete spatial summation (Ricco’s area) for standard perimetric stimuli, between amblyopic eyes and their fellow non-amblyopic eye, and to compare any such inter-ocular differences to those in observers with normal binocular vision.

Methods: Achromatic contrast detection thresholds were measured with circular incremental stimuli of different area (Goldmann I-V; 0.02°–1.7° diameter) at 12 visual field locations (9°, 15° and 21° eccentricity; 4 locations each) in observers with strabismic amblyopia (n=2; age: 19, 23 years), anisometropic amblyopia (n=3; age:18, 19, 20 years), and normal binocular vision (n=5; mean age: 25.8 years, range: 20, 31). Background luminance was 10cd/m². Experiments were performed on an Octopus 900 perimeter (Haag Streit, Koeniz, Switzerland), with the Open Perimetry Interface. Thresholds were averaged by eccentricity and three spatial summation curves were constructed for each eye. Ricco’s area was estimated from each by two-phase regression analysis. Estimates were compared between amblyopic and fellow non-amblyopic eyes at each eccentricity. Inter-ocular differences at each eccentricity were compared between observers with and without amblyopia.

Results: Ricco’s area was significantly larger (mean: 0.3 log deg²) in amblyopic eyes than in fellow non-amblyopic eyes at all eccentricities (p<0.01, paired t-test, Holm-Bonferroni correction). Inter-ocular differences in control subjects (mean: 0.03 log deg²) were not statistically significant (p>0.05, paired t-test, Holm-Bonferroni correction). Compared with control eyes, mean Ricco’s area was larger in amblyopic eyes but smaller in non-amblyopic eyes (Figure).

Conclusions: Given that changes in receptive fields of retinal ganglion cells in amblyopia are not marked, our findings likely point to a difference in representation of each eye at the cortical level. Greater convergence of signals from retinal ganglion cells in amblyopic eyes to thinner ocular dominance (OD) columns in V1, and less convergence from those in the fellow non-amblyopic eye to thicker OD columns, may explain these results. These findings also support the concept that the physiological basis for Ricco’s area reflects processing along the entire visual pathway, and is not confined to the retina.

Mean Ricco’s area as a function of eccentricity in amblyopic, non-amblyopic and control eyes. (Error bars: SEM)

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Do different mechanisms mediate contour interaction and crowding in the fovea and visual periphery?

Stephanie M. Marten-Ellis, Harold E. Bedell. College of Optometry, University of Houston, Houston, TX.

Purpose: To compare the influence of nearby flanking lines (contour interaction) and flanking letters (crowding) on the identification of foveal and peripheral letters at different luminances.

Methods: Single Sloan letters were presented at the fovea or at 5 deg in the inferior visual field, with and without 4 flanking bars or flanking letters placed symmetrically to the right, left, above and below the letter.
below the target letter. Background luminance was either 200 or 0.5 cd/sq.m. For each combination of eccentricity and background luminance, letter size was adjusted to produce 80 – 90% correct identification when the flanking targets were absent. Percent correct letter identification was then determined for 5 to 8 edge-to-edge separations between the flankers and Sloan letters in 2 normal observers. The bar flankers subtended 1 x 5 letter-stroke widths and the letter flankers had the same dimensions as the letter targets.

Results: At the fovea, the extent of interaction (the maximum target-to-flanker separation that influenced performance) was approximately 3 – 4 min arc for both bar and letter flankers. The magnitude of interaction (the maximum reduction of percent correct letter identification) also was similar for both types of flankers, but decreased dramatically at low compared to high background luminance. At 5 deg in the inferior field, the extent of contour interaction for bar flankers was approximately 4 times smaller than the extent of crowding for letter flankers. Reducing background luminance had no effect on either the extent or the magnitude of peripheral contour interaction or crowding.

Conclusions: At the fovea, bar and letter flanking targets interfere with letter recognition based on the same luminance-dependent mechanism. In the periphery, contour interaction and crowding are independent of background luminance but flanking bars impair identification much less strongly than flanking letters. The results suggest that flanking targets influence foveal and peripheral letter identification by different mechanisms.

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Crowding in simulated monovision

Zuopao Zhu1 2; Hua Bi2; Bin Zhang2; Ziming Liu1 3; Zheyi Chen1; Binbin Su1; Jun Jiang1; Fan Lv1
1Optometry Department, The Affiliated Eye Hospital of Wenzhou Medical University, Wenzhou, China; 2College of Optometry, NOVA Southeastern University, Davie, FL; 3Shenyang He Eye Hospital, Shenyang, China.

Purpose: Monovision is the presbyopic vision correction practice of prescribing distance vision in one eye and near vision in the other eye. With blurred image in one eye and clear image in the other, the visual system experiences more binocular masking/suppression/ rivalry. About 20%-30% patients with monovision have reported discomfort, indicating certain impairment in visual function. The largely normal visual acuity, which represents the foveal visual function, indicates peripheral visual disturbance in those patients. Crowding refers to the reduced object identification ability in the periphery when the target object is flanked by distracters. It is a binocular process and other binocular processes that are ongoing simultaneously could interfere to amplify the impairment to object identification. In this study, we tested whether crowding is much more severe in simulated monovision condition.

Methods: 20 subjects participated in this study. Cycloplegia was induced by instillation of one drop of 1% tropicamide and an artificial pupil with 3mm diameter was applied. Monovision was simulated by full correction in one eye and correction with +2.5 D defocus in the other eye. The crowding effect was quantified by reduction in accuracy when identifying letters (5’ eccentricity from the fixation) with flankers at 5 different spacing (0.44, 0.88, 1.32, 1.76, 2.4) as compared with no flanker. For each subject, the crowding effect was measured both in normal and simulated monovision condition. Accuracy of letter identification and area of error identification were calculated. Z-test was applied to test if the accuracy of letter identification and area of error identification changed significantly in simulated monovision condition.

Results: The accuracy of letter identification, when tested without flankers, was similar in normal and simulated monovision condition. However, with flankers, the accuracy of letter identification was significantly lower in simulated monovision condition at all spacing (P < 0.05), and the changes of accuracy between them at 5 different spacing were significantly different. (P < 0.05) The area of error identification was significantly higher in simulated monovision condition (3.32 ± 0.47) as compared with normal condition (2.31 ± 0.59). (P < 0.05)

Conclusions: The crowding was much more severe in simulated monovision condition than normal viewing condition, and the difference was dependent of the spacing between the target and flankers.

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Digital self-assessment application for identifying ADHD symptoms


Purpose: ADHD is a common neurobehavioral disorder. ADHD is diagnosed by clinicians using subjective tools, sometimes supported by a computerized test. However, since this diagnosis requires visiting a clinic and is affected by external factors such as intelligence and fatigue, many cases remain undiagnosed through adulthood. There is a societal burden associated with undiagnosed ADHD, creating a need for objective tools for ADHD preliminary self-assessment, prompting seeking professional clinical diagnosis if relevant.

Here we aimed at testing whether we can manipulate spatial and temporal stimulation to identify ADHD symptoms in adults. To this end, we used a short, self-administered tool based on dynamic crowded visual stimulation to identify ADHD symptoms. Various studies demonstrated the usefulness of crowded conditions for measuring visual performance in aging adults and children.

Methods: Measurements using a prototype dynamic digital assessment tool, currently developed by GlassesOff™, on smartphones, which reliably measure functional near visual acuity (VA), were compared between diagnosed-ADHD and control groups: 24 ADHD subjects (aged 16-28 years, with an ADHD diagnosis performed by a neurologist or psychiatrist) and 18 controls (aged 20-30 years), all corrected to normal vision (worst binocular VA 0.04 logMAR). Stimuli consisted of matrices composed of 25 letters “E” (5x5), each with a randomly chosen orientation having 4 options. Two variations of inter-letter-spacing within the matrix were used (0.4 and 1 letter size). Participants were requested to identify the orientation of the central letter. VA thresholds were determined using a staircase measuring the minimal detectable letter size, under crowding conditions and the stimulus presentation ranged from 34 to 120 msec.

Results: Despite normal VA on the clinical static ETDRS chart, our self-administered test showed a large and significant VA reduction in ADHD subjects compared with controls: 62, 79, and 64% for 34, 60, and 120 msec, respectively, equivalent to about 2 ETDRS lines. Similar results were obtained for 0.4-letter spacing.

Conclusions: Our self-administered dynamic digital tool may be used for objective assessment of ADHD symptoms. We suggest that
under-development of visual functions, which is present in children under regular conditions, persist in adults with ADHD symptoms and that this becomes apparent under spatial and temporal loading conditions.

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